ANALOG

SCIENCE FICTION AND FACT

AUGUST 1993

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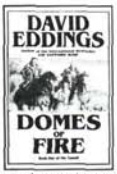

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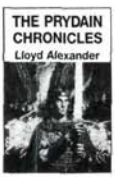

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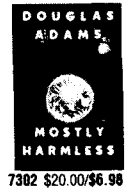

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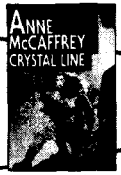

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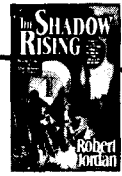

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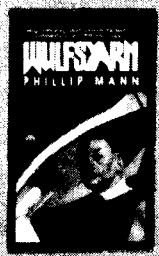

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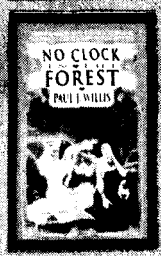

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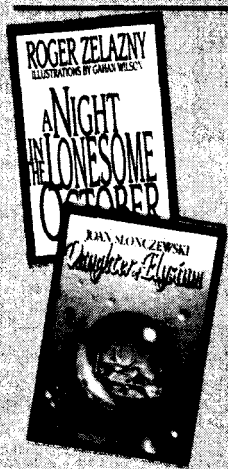

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EDITORIAL Stanley Schmidt

UPSTART INSTRUMENTS

There's a common tendency to regard art and technology as quite separate and distinct. They're seen as the two contrasting halves of a sharp dichotomy, as in the cliché, "An art, not a science." Sometimes they're even seen as antagonistic, "artsy" types looking with disdain on anything as "cut and dried" or "nuts and bolts" as science or technology.

In reality, of course, it's not that simple. Every art depends on one or more technologies as its tools, and artists tend to embrace eagerly new techniques that help them get the effects they want more easily or effectively. Painters who once would have worked with oils and camel hair now are at least as likely to use acrylics and airbrushes. Writers who would have used quill pens when this country was new graduated a century ago to typewriters, and a decade ago to word processors. Trumpeters are constantly trying new mouthpieces and leadpipes to improve their instruments' performance; clarinetists experiment with reeds and ligatures. Composers, like authors, have software to facilitate their work.

Yet there is resistance, too. Orchestras have long tuned to an A provided by an oboist, but in recent years pocket-sized electronic tuners have become commonplace and some conductors prefer them as their pitch standards. Oboists sometimes feel insulted by such a preference, feeling sure that they can provide at least as reliable a pitch as "that box." But the fact is that they can't. It's not their fault, and they shouldn't take it personally. The physics of the two systems simply dictate that there's no way a vibrating air column in a wooden tube can be as stable and reproducible in frequency as a quartz-controlled electronic oscillator. So oboists are probably going to have to resign themselves to being replaced more and more often as the pitch standard for orchestras.

A hot topic among professional

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musicians lately has been, "What can we do about the electronic upstarts that are horning in on our turf?" Union newsletters are full of articles and letters about the perceived threat to musicians' livelihoods posed by electronic instruments such as synthesizers and the growing prevalence of recorded, rather than live, music.

Those are really at least two separate issues. Keyboards and synthesizers are, at least in first approximation, simply new kinds of musical instruments. Viewed that way, it seems oddly ironic that some of the people who feel they must be protected from "unfair competition" from these newfangled contraptions play things like saxophone (which was a newfangled contraption in 1846), valved brasses such as trumpets and French horns (circa 1815), and piano (which was invented in 1709 and began displacing the harpsichord around the middle of the 18th century).

Some musicians realize this, of course. Along with the doom-crying letters and articles are others pointing out that this is by no means the first time new instruments with new abilities have come along, and that it might be more prudent to learn to take advantage of them than to bewail their existence.

Synthesizers, admittedly, are not *just* a new kind of instrument. What makes them threatening to traditional musicians, and not without cause, is the fact that a single synthesizer can, for at least some purposes, replace not just one or two instruments, but an entire orchestra. (Or chorus! Tchaikovsky's *Nutcracker* includes some passages for women's chorus; I've played performances in which the "chorus" was a Yamaha keyboard and nobody I asked in the audience had the slightest suspicion that it was anything but a women's chorus.) Already a very large percentage of music for radio and television commercials is completely synthesized.

Does it matter? Certainly it does if you've devoted a lifelong career to playing in orchestras, and suddenly nobody wants to hire orchestras any more. It matters to a lot of other people, too, even if they don't depend on playing in orchestras to make a living. Music provides only a small fraction of my income, but a large and important part of what I depend on to keep myself sane. I know of no other experience that provides quite the same kind of high as playing a really

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good part with a really good symphony orchestra.

Yet I also know that symphony orchestras are very expensive to run. The real question about their survival is whether enough audiences will continue to think that a live concert by a hundred living and cooperating human beings is special enough to warrant that expense. For my own personal reasons, I hope so. But I also recognize that it may not turn out that way, and someday I may have to find other ways to fill the void.

Recorded music poses a different kind of problem. Here the perceived enemy is disk jockeys, in whatever form they may take. Live musicians still make the recordings, but one recording session to make a disk that can then be played at hundreds of parties obviously provides far fewer jobs than would hiring a live band for each of those parties. Royalty payment requirements make some attempt to fill the void (did you know that part of the price of every recording you buy goes into a fund to help finance live performances?), but they make a relatively small dent in it.

Musicians understandably find this disturbing, but what can they do about it? There is no innate inalienable right to make a living as a performing musician (or in any other particular way that might strike someone's fancy). The jobs will be there as long as, and only as long as, customers find the service worth paying for. So the best, even if most difficult, course open to musicians who

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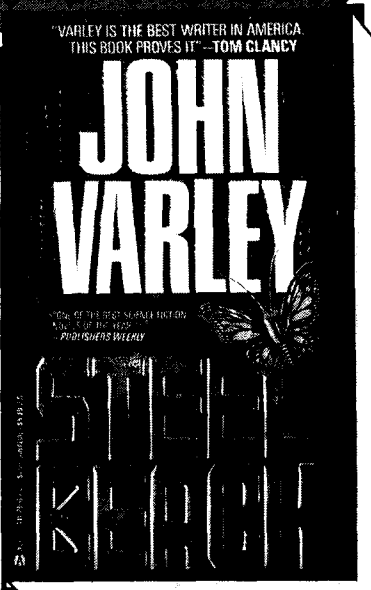
The tube capsule back to King City was a quarter full. I used the time to try to salvage something from the wasted afternoon. Looking around me, I saw that all my colleagues were busy at the same task. Eyes were rolled up, mouths hung open, here and there a finger twitched. It had to be either a day trip from the Catatonic Academy, or the modern press at work....

Okay, so I lied about the open mouths. Not all D.I. users look like retarded zombies when they interface. But they look asleep, and I've never been comfortable sleeping in public places.

— Excerpted from *Steel Beach*



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want to keep working is to convince the public that what they provide is worth buying.

On the other hand, sometimes it's hard to see what the long-range consequences of an innovation will be. It's quite obvious that the *immediate* effect of a growing reliance on canned music is fewer jobs, but not all effects are immediate.

When magnetic tape recording became widespread in the late 1940s, it made record production so much easier and cheaper that many more people got into the field. As the *Encyclopaedia Britannica* put it, "Anyone with a good recorder and a microphone could become a record producer. Small companies sprang up in areas of music ignored by the giants: the esoteric and the avant-garde, the music of the periods before and after the highly popular Romantic classics of the 19th century. Chamber music, as well as Baroque works of the 18th century and earlier . . . flooded record stores and resulted in an unprecedented Baroque revival . . . All-Vivaldi concerts were sold out, and Bach became a best-seller."

In other words, the explosive growth of recording not only created employment opportunities for musicians to make recordings (even if the later playing of those recordings might eliminate some gigs), but it also *created new markets for live music* by awakening an interest in kinds of music the public had previously had no chance to hear. People who discovered Telemann or Mahler for the first time on records wanted to hear it in concert—so musicians were hired to play it.

Admittedly the difference in sound quality between recordings and live performances was a lot bigger then than it is now; but it's still there, and sound quality is not the only factor involved. Many people still find enough special excitement in hearing and seeing a performance in a real hall and in real time, by real people, to justify shelling out the added expense. The challenge, if musicians want to keep being hired to provide that excitement, is twofold: to make sure the public has the experience often enough to be aware of the difference, and to tame the economics so that they can afford to do it reasonably often.

And, of course, many people will still want to *make* music. The difference between listening to a record, listening to a concert, and playing a concert is something like the difference between looking at a picture of the Alps, riding through the Alps on a bus, and climbing an Alp with your own muscle and lungs. The extra satisfaction repays the extra effort so richly that some people consider it unquestionably worthwhile. In music, there are a lot of ways to get that level of personal involvement, such as singing, composing, or playing any of a wide variety of instruments. Choices must be made; any one of those pursuits involves so much learning that no one person is likely to master very many of them.

How many people make what choices will certainly affect the future shape of music, at both amateur and professional levels. You can't

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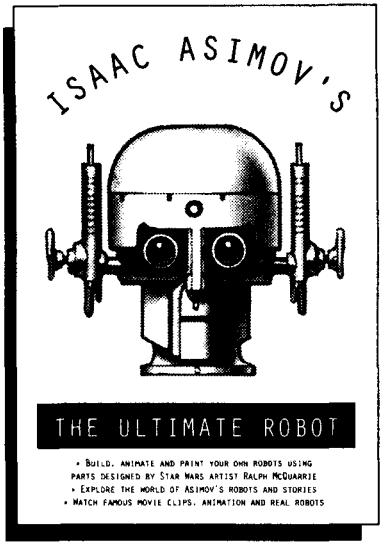
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have many symphony orchestras, for example, unless relatively large numbers of people learn to play bowed string instruments—which has long been a major problem confronting people who want to make sure symphony orchestras survive.

It's hard to doubt that electronic instruments will attract more and more would-be music-makers. They've already been doing it for quite a few years (if you could walk into a typical music store now and then visit one from the Fifties, you'd be astonished at the difference in inventory), and they'll go right on doing it. An electronic keyboard or synthesizer allows a single player to do so much more of some kinds of things than any acoustic instrument that it would be unrealistic to expect people *not* to be drawn to them.

Yet some will continue to be drawn to the others, too, just as people continued to play clarinets and guitars even though pipe organs were available. A common argument for this *now* is that electronic instruments *sound* electronic. A "trumpet" or "violin" or "oboe" stop on a keyboard seldom sounds enough like a trumpet or violin or oboe to fool anybody familiar with the real thing. But this, too, will pass. It's the "primitive machine" effect, a consequence of the relatively primitive state of the contemporary art rather than an intrinsic limitation of electronics. Electronic imitations are getting better all the time, and their inadequacy will be less and less of a reason to play (or hire) an acoustic instrument rather than electronic.

I think the more effective reason will be the difference in *feel*. A synthesizer in skilled hands can give the player the exhilaration of producing complex and impressive sounds all by himself. Playing in an orchestra gives a different but comparable kind of exhilaration: that of being part of a single huge instrument whose components are human beings.

Upstart instruments like synthesizers, tape recorders, and computers broaden the range of options—just as pianos and saxophones did when they came along. They give people more choices. The future of music will be a different—and ever-changing—combination of ingredients from a growing palette. I wouldn't venture to guess exactly what it will look like at any time, but I don't think it's going to be dull. I can even imagine some peculiar hybrids, such as electronic imitations being used to augment string sections for people who want to keep symphony orchestras alive but can't find enough violinists or violists.*

A while back, in talking about the fact that even professions and available job choices evolve, I made a passing remark about "the death of the buggy-whip industry." An attentive reader named Margaret Gardiner wrote in to tell me, "Actually the buggy-whip business is doing pretty well. Connecticut alone has three manu-

*Ironically, the day after printing this out I went to a performance of a musical in which the pit orchestra was reduced to seven pieces by using two keyboards in lieu of a string section. This is the dark side of all this: using a cheap imitation to save a few bucks when the real thing is readily available!

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facturers." So the buggy-whip business is not really dead—but it certainly isn't what it used to be. Connecticut also has more than three *million* residents. At the turn of the century, one buggy-whip maker per million people would have been woefully inadequate. Now it's enough, because while there are still a few people who want buggy whips, there are a great many more who want other things—many of which did not exist at the turn of the century, such as minivans, calculators, television sets, and microwave ovens.

So has it been, and so will it be, with music. There are still a few people who play harpsichords, shawms, and sackbuts—but there aren't nearly as many job openings for them as there once were. On the other hand, there are a lot *more* jobs for pianists, saxophonists, and tubaists. A hundred years from now, there will very probably be fewer openings for *them*—but more for things we haven't even thought of yet. ■

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Half the world is composed of people who have something to say and can't, and the other half consists of people who have nothing to say and keep on saying it.

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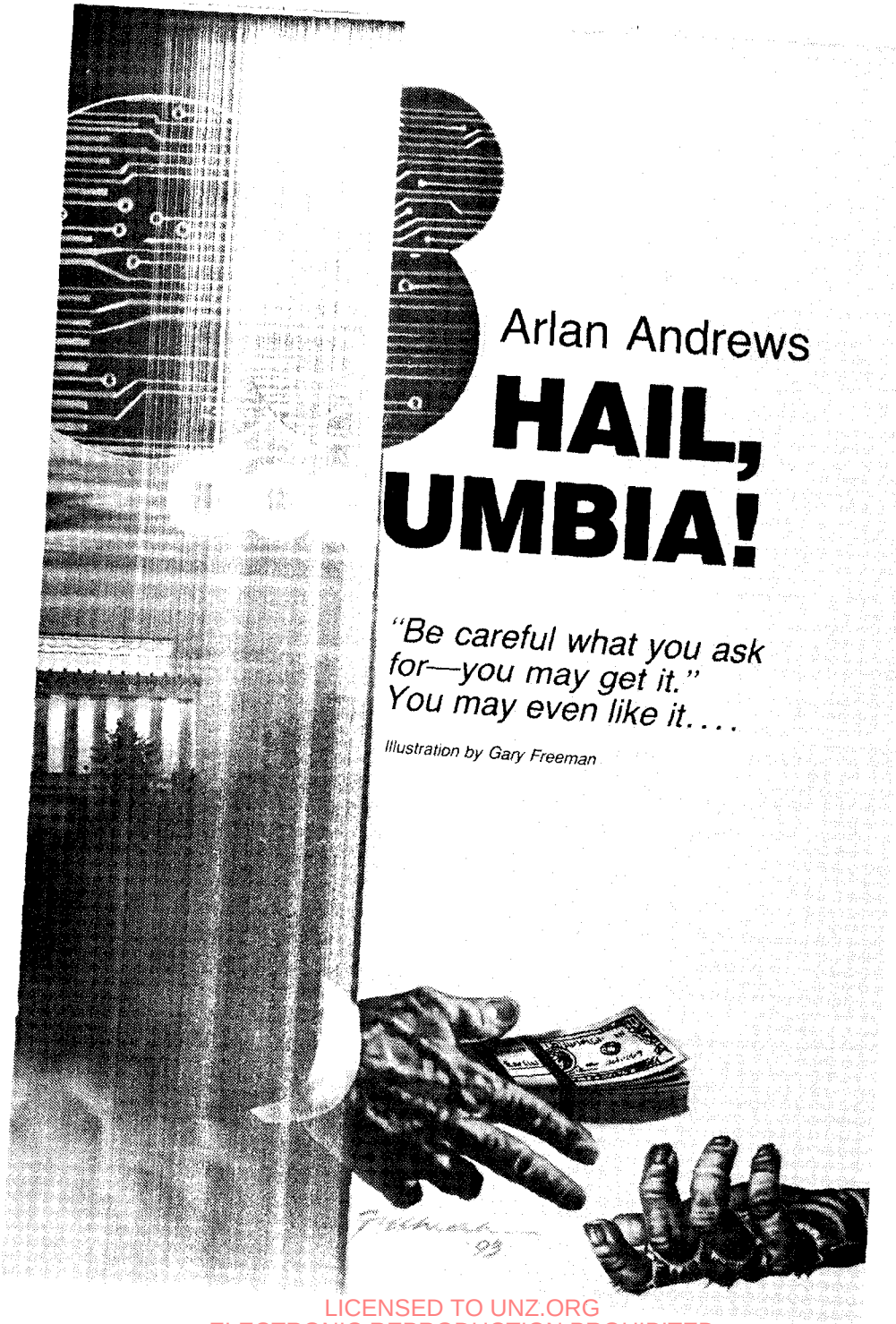

Arlan Andrews

HAIL, UMBIA!

"Be careful what you ask for—you may get it."
You may even like it....

Illustration by Gary Freeman

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Soul-chilling gusts swept the dirty streets of downtown Washington, whipping up a snowstorm of discarded newspaper pages. Other winds intercepted the flying paper debris, plastering it in layers onto a pile of trash already filling a dark, gaping alcove in the wall of a stone-gray government building. From within that featureless mound of loose rags and bundled plastic bags, something stirred.

First one hand, then two, scarcely covered by threadbare, fingerless gloves, emerged hesitantly from the refuge of their amorphous shelter, like moray eels searching for prey. Finding the flapping newsprint, the hands flung off the unwanted layer of new material, to be carried off into some other resting place in the city-state of New Columbia. The dark appendages quickly retreated back into their fouled nest. Deep inside the one-man lair, a ragged, miserable figure shivered in resignation, rubbing his frigid hands for warmth.

If it got any colder, he'd be lucky to live through it, he thought. The local government, sensitive to the needs of the new state's tax-paying citizenry, was determined that Columbians would be spared the sight and the visual guilt of the "domicile disadvantaged," the DDs. So last summer they fenced off the once-hospitable exhaust heat vent gratings where Jorge and other DDs had survived the last winter and the one before that, back—how far back? Jorge couldn't remember. Damn, but it was cold. Down to zero, Old Mac had said this morning, but was that zero *fairin' heat* or zero *seltzerus?* No matter. Cold is cold.

"Jorge," a soft voice said, breaking the near-silence of the chilling winds. Losin' my mind?, Jorge frowned. He didn't like being called by name; he didn't like even being seen. His key to survival on these streets was to blend in with the background ugliness, and not be noticed. "Pile of trash ain't no threat to nobody," Old Mac whispered. "Ain't nothing worth nothing in no trash. Only trash looks in trash." Jorge quietened him.

"Jorge," the soft voice repeated, more insistent this time. Old Mac didn't comment further.

Jorge tensed his muscles, trying to muster the little remaining strength and limited flexibility from his complaining limbs. His only weapon, a large nail, he kept in his cupped left hand, ready for defense. It would be a pitiful fighting tool, he knew. But I get caught with anything bigger, I get kicked out of N.C. for good. Slowly he lifted the meter-square scrap of plywood that protected his head and offered him a quick escape from his home. He peered out through a tunnel of trash at the unwelcome inquisitor. "Yeah, yo. What yah want?"

The visitor to Jorge's den was short, but expensively dressed in a fashionable topcoat and a kind of funny floppy hat that shaded his face. Even in the dark shadows, the man's body language told Jorge much about him. White boy, he concluded. A glimpse of the Cadillac USport Electric parked at the curb across the street told him additionally: Georgetown, Collie. Colliberal Party, Ameri-

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cans First and Always. That was a good sign. "Not from jay-cee penny, good for least a twenny," Old Mac volunteered. Jorge didn't know the literal significance of the rhyme, just that it meant the now-welcome intruder might spring for a couple days' warm food, some good hooch.

"Jorge," the man said, coming within arm's reach, "I have something for you. A gift. A donation." Jorge slowly snaked an arm out from his dwelling pile, palm up. The man thrust a sheaf of bills into the waiting hand. "Buy yourself a meal, my homeless friend," the mysterious stranger said with a friendly smile. "In fact, buy yourself a life."

His instinct for self-preservation taking hold, Jorge jerked his hand back in to the relative safety of his hidey-hole. He fondled the embossed bills in the darkness, the raised likenesses of President Cuomo—Five fifties! Damn, doubledy-damn, he swore silently. "Never, ever, tell the worl' when you got bux," Old Mac said quickly. "Keep yah forchoon untold!" But, ohgod ohgod, this old boy here, we got—how much? Two hunnert—two fifty bux! Jorge slipped the separate bills into as many different hiding places inside his five layers of sweaters and parkas and pants and shorts. His mind buzzed with possibilities: a hot meal first thing in the morning, over to the Old Post Orifice across the street. Some good hooch, liquor store next to the Press Building. New pair o'gloves? Nah. "Your cold hands, warms their hearts," Old Mac reminded him. Jubilant but still quiet, Jorge looked out from his soiled castle at the frigid, unforgiving night. Nobody near. The Collie was gone. Jorge reprimanded himself. "Got to remember their faces," Old Mac said. "A wink, a word, your message is heard." Jorge nodded, Old Mac was right. Thanks is free, got to be given freely. Always pays.

Old Mac droned on, but Jorge tuned out the homilies as best he could, thinking out how to use this fantastic good fortune to best advantage. The whores up on 14th, what they charge? Jorge was truly happy for the first time in memory. Damn, but he felt good. He wanted to keep on feeling good. He pulled out a precious bill and stroked it, bringing it close to his nose. No smell, and feels kinda greasy, he thought, but a good greasy. Warms the fingers, even. As he lay back in his den, warmth suffused Jorge's body, starting from his limbering fingers, spreading up his aching, needle-tracked arms, crawling across his bursitis-stricken shoulders, finally claiming the ravaged territory of pinched nerves and ruptured disks down his spine and up his arthritic neck. It was incredible. "Damn, good as a woman, better'n crack," Jorge muttered as pleasure invaded every facet of his being. In fact, there hadn't been sex with another person for years, and what he experienced as ecstasy other people would have simply called good health and well-being.

"Jorge, I think something is happening to us," Old Mac said, a tinge of uncertain fear coming through. Jorge didn't answer.

Sometime, during the night, Old Mac died.

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* * *

Something tickled his nose, causing Jorge McHenry to wake and greet the cold blue dawn. "Damn, but it smells in here!" he said aloud. Right in his face hung the fraying plywood splinters that had roused him from the most peaceful night's sleep he had ever known, truncating the most intense and stimulating dreams he had ever experienced. He thrust out both arms, pushing aside the ragged wooden cover, and gagged at the smell of the rags and bags that enveloped him like a soiled womb. He stood erect in the mound of detritus that was his home of many years. As cold new sunlight stabbed his rheumy eyes, Jorge almost stumbled over the trash he had once loved, trash that had protected him from the street jungle of New Columbia.

"God, it's *me* that stinks!" he shouted to himself, scaring back-stepping commuters who scurried past his shabby niche without a second conscious look. For the first time, Jorge experienced their reactions —the averted eyes scouring him mentally, a thrust of uncertainty here, that jab of fear there, the occasional broadsword blow of utter disgust. God, is that how they feel about me? Looking down at himself his semi-gloved hands—the fingers unclean, wriggling worms—threatened him. He peeled off the accusing hand coverings and tossed them onto the infestation of trash he had called home.

"Salvation Army first, for a bath and a meal and used clothes. Then—" He hesitated as a jumble of new knowledge, confusing at first, clarified itself in his mind. He felt—no, he *remembered*—the heft of an automatic socket wrench in his grasp, the smooth, sensual tactility of highly-polished newsteel, the satisfaction of coaxing his nine-axis nanomill, churning out new hypertech products, day in, day out, making—*money!* He even knew the name and address of the—factory?—where he worked. *Would* work. And the comfortable apartment where he lived. *Would* live. These strange memories were unfamiliar, but welcome, even as they seemed to be jostling aside other, less pleasant ones. Days of begging, nights of cold and fear. "By God, this two hundred fifty bux for *new* clothes and a taxi to the employment office!"

Old Mac didn't comment, was wholly quiet, the first time in years. Jorge paused, wondered about his strange thought. Old Mac? Now who the hell was that? Shaking his head as if to clear out faint echoes of another time, another personality, Jorge McHenry promptly dispatched the dim and dirty past and strode confidently, rags and all, toward a changed future and a different life.

"A hundred and thirty murders in one week?" Governor-Mayor Eldon Gray whistled low, scanning his wrist-comp display, scouring his latest Developing Intelligence software analysis of the police reports for the third time. But the news was still all bad. "A hundred and thirty DDs, all gone, vanished!" he groaned again, hopefully still low enough that the office holocorders didn't notice. "The

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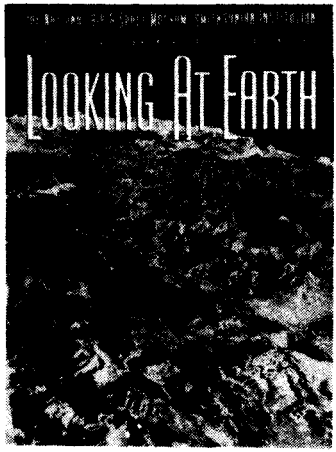

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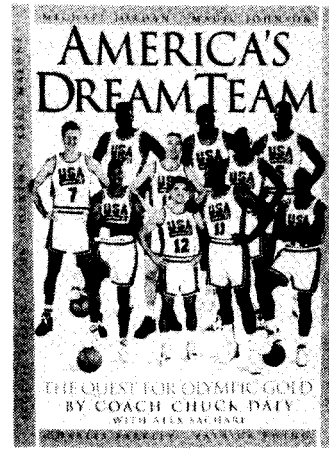

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streets of New Columbia aren't even safe for street people!"

Gray was upset. One of his proudest achievements had been nearly ridding the old District of Columbia of street crime; a sudden relapse back into the old days—*hundreds of murders!*—would derail his provisional city-state's still very tenuous support in Congress. He shook his head in dismay. He wasn't yet strong enough politically to recover from a scandal like this, once it broke into the media. He thanked God and his friends in the Institute for Creative Anarchy for the private DI program that analyzed the communication traffic of police and state officials. Unconsciously he stroked a tiny tattoo on his left forearm, which constituted the control panel. Good old D.I. Duke! This wasn't the first time the DI had helped Gray intercept an important problem ahead of the state media. He hoped it wouldn't be the last.

Governor-Mayor F. Eldon Gray headed only a "provisional state," according to the monthly reminders from an increasingly hostile Congress that was still the ultimate governing body of the nation's capital district. Gray had hoped to keep parlaying his record as former D.C. chief of police into sufficient political capital for the outright recognition of New Columbia as the fifty-third United State, but the DD business could threaten it all.

The disappearances might be ammunition enough for the city-state's enemies on the Hill to undo the provisional status and slap N.C. back again to plain old D.C. Gray clenched his jaw at the thought; he couldn't allow that.

He stood and sighed, rubbing one large black fist into an open palm. He had fought hard and long for the Drug Administration Relief clinics that revolutionized the street life of old D.C., and he would not give up everything he'd dedicated his life to, just for a few dozen DDs, no matter what had happened to them. Not only that, but he also intended to be the first real senator of New Columbia, the one voting senator who would be seated when statehood was granted; that was the compromise the Hill had offered. The two observer-only provisional senators were a joke—a worn-out Collie harridan and an old, washed-up Poppie preacher.

Senator F. Eldon Gray—if he could solve the for-real DD problem, and very soon. His old D.I. friend, Duke, was definitely a help, but right now he'd have to work with somebody who could get out on the streets, probably one of the lower-level detectives, one he could trust to be discreet. One who would want a promotion, and eventually a shot at the chief's job. A wry smile worked its way to his lips. Being a purveyor of favors was one great perk of political power. Like all successful political office holders, Gray found that such perks were merely some of the tools necessary to get the job done.

"Detective Lavender, come in, have a seat," the governor-mayor said, taking the young man by the arm. "I've got an assignment for you, a *confidential* assignment." Lieutenant

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Jay Lavender took his superior's suggestion as an order and sat, facing the G-M's desk as Gray settled into his myo-chair. Gray saw a thirtyish man, thin and tall and dark-skinned, wearing a dicktracy yellowcoat and matching fedora. For an instant the costume, fashionable as it was this year, caused him to wonder if he'd made the right decision. Already Gray had worried about the troublesome officer's psych-soch-med profile. In his video personnel file, Lavender attributed his intermittent drug usage and episodes of domestic violence to a ghetto childhood upbringing. But reassurance returned to Gray as he remembered the high marks Lavender had racked up in all the intellectual and physical skills tests. Including hacko tech; that might be useful.

"Lieutenant Lavender, New Columbia has lost—" Gray checked his wristcomp display again "—almost 150 DDs in the last seven and a half days." He stared at the detective intensely, letting the astonishing facts sink in. "I want you to find out what's going on, and do it quickly."

Lavender was confused. "*Lost*, sir? Dead, murdered, kidnapped?" Gray shrugged, and the detective could tell by the G-M's reaction that no one knew. Oh great, the young man thought, I've gotta go dig up personal histories on a couple hundred no-guys. "Wait a minute, sir! A *hundred and fifty*, you said?"

Gray nodded. Lavender whistled. "No ideas, sir? No bodies?"

"Not a one. You tell me." Gray stood and walked to the large window. He loved the view from here: pink dawn washed the monuments in pastels, giving Washington and Lincoln tributes in soft rose shadows. He sharply turned away from the Lincoln Memorial, refusing to allow traumatic memories to surface, of Zerah's blood on its steps, her dying in his arms.

Facing Lavender, he waved an arm at the Washington. "They're gone —vanished. Far as we can tell, no blood, no violence. Just up and left their usual concrete residences, all their trash behind, and went—where?" His voice tone dropped. "Son, this is important to me and to New Columbia. If we have a massacre on our hands—" The sentence hung in the air, unfinished.

Lavender nodded. "I know the talk on the Hill, sir. We backslide to violent crime, Congress'll un-provision N.C. and we won't be a state anymore. And that means no more DARs. . . ." His voice tapering off as he rose, he shuddered to think of a return to D.C., of the drug violence that was ruining Virginia across the river. "I'll do it, sir. Shouldn't be that hard to find a couple hundred downers."

Gray didn't like the use of that term, although he was aware that to some people, "DD" meant "down and dirty." But smiling, he took Lavender's hand and pumped it, and handed over the microprint from his wristcomp display. He sensed something in the man's attitude, a tenseness, an uncertainty. "A problem, Jay?"

The detective hesitated, pursing his lips. "Just one, sir."

"And what's that, Detective Lavender?"

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"With all that filth removed from our state, who wants to find them? Who really cares?"

Governor-Mayor Eldon Gray just nodded, staring silently down the hallways as his knight left the office and went to do battle with the forces of—what? In the distance, the Washington Monument glowed like a rosy spire of imperial majesty.

Detective Lavender left the Governor-Mayor's office with mixed emotions. Obviously, the G-M wanted this done quietly as well as quickly, and the detective was grateful for the opportunity to help the G-M and N.C.

"Five years provisional city-state. Long enough, you ask me," Lavender murmured to himself as the gas engine whirred up to speed. He accelerated into the morning traffic, thinking he'd have to go to the streets for this one, not that he didn't trust the G-M. "But politicians do fly off the handle too fast sometimes. They need to be checked up on. They're no smarter than us average guys." He headed toward the DD haunts around Adams-Morgan and the NorthWest. Later he'd go down to the SouthEast and Anacostia.

An hour later, Detective Lavender was upset. He had spent the first half hour of that time cruising N.C.'s worst DD hangouts, including the Metro stations, finding them pleasingly clean and free of downers. By God, he wondered, how the hell could 150 of these no-guys just up and get gone? A quick check of police records showed no hundreds of corpses turning up anywhere, no signs of violence. And why did they leave? All right, the weather was pretty freeqing frigid, but no worse than other years, that couldn't be it. Besides, they left their blankets and coverings behind. Couldn't be robbery either. These no-guys had nothing to steal, and the little trash that they had was still piled up all around town. Just one empty pile of rags and bags after another, dozens of dilapidated, overstuffed shopping carts left abandoned.

Shaken, Lavender had spent the next thirty minutes reviewing the G-M's microprint police files on the case. Somehow, the G-M had sifted all the DD data from routine police and surveillance camera reports, and some other stuff Lavender didn't know you could legally get, and had come to the conclusion ahead of everyone else. Smart guy, the G-M, Lavender thought. Or else, he's got the best freeqing DI system going! He voice-dialed up the carphone and activated some of his own netsearch capabilities, even going so far as to instruct his homecomp to start assembling a hydra, the hacko's ultimate helpmeet. Smiling at his own suspicions, Lavender thought, You never really trust a politician, not even your own!

As he steered the gasser into his tiny garage, Detective Lieutenant Lavender decided that tonight he was going to become a DD himself, undercover. Under dirty, stinking, ragged covers. Yulia would just love it. He could hear her Slavic bitching now.

Jay Lavender was bundled up in

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multiple layers of old clothing purchased from several downers, glommed from abandoned piles of DD trash, and found in used clothing stores. From all outside appearances, he hoped, he was just another useless DD, pushing a rattling shopping cart next to the old Metro stop where several of the last day's disappearances had occurred. He settled into an abandoned alcove that looked like it would keep away most of the direct blasts of winter wind. In a territory-marking ritual reminiscent of other male mammals, he urinated on the wall, spraying his effluent over the dirty concrete wall and watching as it trickled down to cover the sidewalk. Unraveling a few filthy blankets and a rotting tarpaulin to cover the wetness and mask the cold concrete, he squatted down on the newly-christened dwelling site and took up residence.

I'm just like any other DD, I bet, he thought, except I come a little better prepared. The comfortable bulge of his pistol next to his chest was a warm presence, fending off some of the nighttime cold that claimed the street as the Sun disappeared behind gray federal buildings. If he were lucky, he could bust this case tonight, but in reality he knew that it might take days, regardless of the G-M's urgency. Thoughtfully, he had set up holo cameras in several of the surrounding office buildings. And he had a squealer on him, too, with enough dBs to shake the dirt off the walls around him. Lavender hoped his preparations would be enough. But as the cold winds lacerated his imperfect den and the street became deserted of pedestrians and cars, Lavender wished he had also brought along some footwarmers and better gloves. How the hell did the DDs survive this shit, anyhow?

After a long, cold hour, Lavender was miserable. Not so much the cold as the solitude. He hadn't dreamed the streets could be so quiet; in his own apartment, there was always music going, either his own favorites or Yulia's, or something the homecomp chose to complement their moods. Or street noises, or parties, or fighting nearby. Always something. Damn, but he hated quiet.

And Lavender also feared the quiet; it reminded him of the too-still form of his big brother Franco, lying in the casket with soft music playing from somewhere in the darkened room. Quiet reminded him of his mother's soft sobbing as they led her away from the gravesite. Quiet always followed the gun battles, like the one that had left Franco quiet on the street. And quiet threatened him with the more immediate memories of Yulia's sulking after their daily battles, especially the times when she was so overbearing that he—. He was sorry that he hit her so much. But damn, he couldn't stand the pouting. The quiet.

Almost before Lavender could shake off his guilt and his memories, a short man was approaching him from across the street. Damn, why hadn't he set up the holocams for a full-street shot? The guy must've sneaked up—no, there was a Cadillac USport Electric across the street. Illegally parked, a part of his mind noted.

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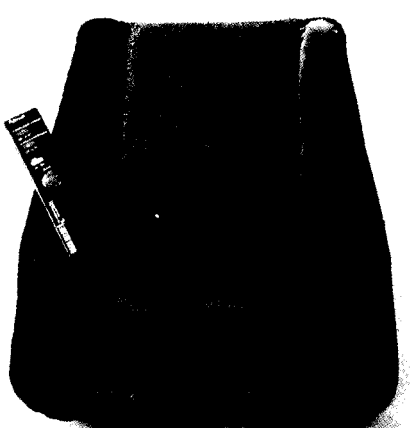

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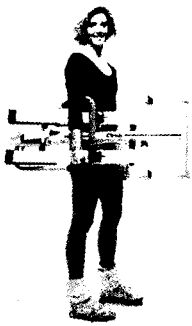

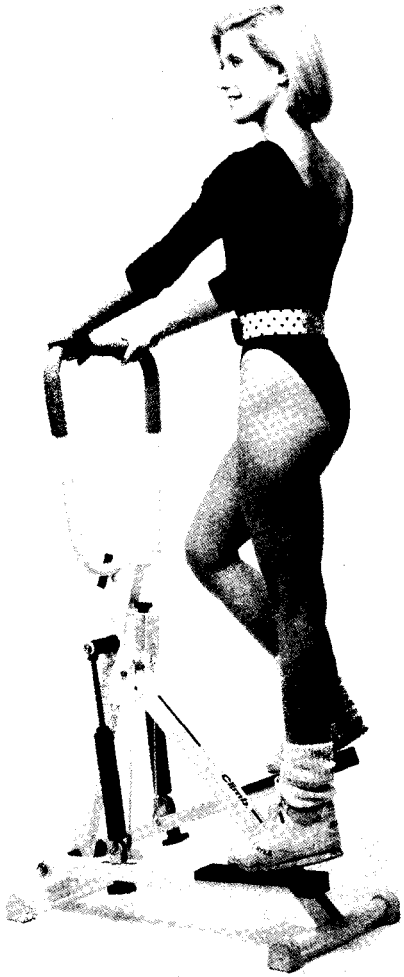

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Those electrics were too quiet, Lavender complained mentally. That's why his car was a full-throated gasser. Tuned up, it sounds like a freeqing rocket!

The man came closer and the detective tried to get a good look, but a wide-brimmed hat hid the face. Like the goddamned Shadow or something, Lavender thought furiously, trying to snake his hand slowly into his chest wrappings to get the flechetter ready. If this was the guy. Hell, he looks too legit to be a crimmer, Lavender thought. Great-looking holocoat, real expensive car. Drugger? No, not here. *Druzhba*'s free here, and the hyperviolent crimmers over in Virgin-I.A. don't export anything illegal this way, no profit in it. No, not a drugger, not a killer. What then? Respectable? Lavender sat, stone silent, wishing for a moment that he could just disappear into his rags and bags until the citizen in front of him just left. He especially didn't want any charity.

How the *hell* did the DDs take this shit, day after year?

"My friend," the citizen said, "this is for you. Live long and prosper." A sheaf of gold quayles fluttered in front of Lavender's face. Hot damn, the citizen was giving him a stack of thousands! Conflicting motivations crossed his mind. This was probably six month's salary. Should he take it, report just a fraction, or not report it at all? Hell, he could be doing this as a real DD, a real downer. Besides, if this guy had nothing to do with the case—and, too, wasn't he on his own time? Yeah, if he didn't report the stakeout, claim any overtime. Lavender decided to take the money; he'd do the right thing later. He was sure.

Purposely shaking his arm to simulate weakness, the detective held out a fingerless gloved palm to take the money. The citizen smiled and put the thin gold leaves in his hand. "Buy yourself some food, my good man," he said, turning to walk across the street. At the door of the USport, he turned and pointed a finger directly toward the holocam locations, each in its turn. His voice boomed down the street, loud enough to be heard by the audio pickups. "In fact, buy yourself a life, Detective Lavender!"

Lavender tried to jump to his feet, but the jumble of his debris-home slowed him down. Before he could manage to fumble through the ragged strata of his bulky clothes to retrieve his flechetter, the USport had *whirred* away. He could have sworn the driver was waving at him as the car rounded the corner and was gone. *Well*, Lavender thought, *at least this is one decision already made for me.* He hoped the incident looked good on disk; there was no way he could disappear the record, not after his name was used by the "citizen." As he bent over to collect the gold quayles, he realized that he had a real break on the case already—some rich citizen in a USport. Couldn't be too many of those around, probably some Georgetown Collectivist-Liberal, an Americans Firster. Certainly no Populist would be seen driving one of those. Or could afford one!

Counting the gold foils in his hand, Lavender realized he'd just lost the

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chance to scarf up an extra half year's pay. Trying not to groan loud enough for the holos to record, he wished he'd taken up downing on his own just for tonight, not as a cop. He held the foils up for the holos to record, announced the total amount in a low voice which he knew the microphone would pick up, and then slid them into an inner shirt pocket. Oh well, at least with the stakeout blown and his cover known, he could leave this shit behind and go home. Unaccountably in the freezing wind, he started to sweat. The damned grease on his hands was irritating his psoriasis; unconsciously he wiped some of it on his face. He shifted the fletch to an outer pocket for protection, and picked up one black plastic sack for protective coloration. Abandoning all his other DD gear, he trudged homeward in the dark.

Half an hour later Yulia met him at the door. "God, Jay, what kind of stakeout are you on now? You look like total shit, you know." She wrinkled her nose at the smell and was prepared to start the nightly ritual of attack and counterattack, when she noticed something different about her lover. Something in the body language, something in the eyes.

"What is it, Jay? Are you on something? Not a toke from the DAR, I hope?" They had both stayed off all drugs for five years; he as part of his job requirements, she because of past sins. She didn't want him to lose his half of their income, get kicked out of N.C. with a dishonorable discharge and therefore be unemployable anywhere else as a cop. But just right now, she didn't want him becoming more violent, either, like he usually did when she nagged him. Her left eye was still swollen shut from last night's encounter. Yet she still loved him, and above all, was worried about his condition. She had to say *something.*

Lavender smiled at his lover with a genial grin. "Yulia, *moya dorogaya,* I do love you. Yes, I am aware I smell to high heaven but that can be taken care of with a nice warm bath." He reached out and gently stroked her bruised face. "This will not happen, again, either, my love. Ever. The very memory of it causes me real pain. Believe me."

Later that evening, as they lay close together, Yulia wondered about the not-quite-healed bruise marks on Lav's relaxed, sleeping face, in the same location as her own. No matter, she was happy. He was a changed man, definitely. After cleaning up, he had turned down her offer of a drink, and instead had done his duty, working on the homecomp for a short while and sending in a report on his night's activities to the Governor-Mayor himself. Then he had made sweet love to her in the gentlest manner, ever. Why, he'd even let her run her fingers through the evidence from his case, that beautiful stack of gold quayles. . . .

The HCLU lawyer leaned over Gray's desk threateningly, her left hand propping up an ample bulk. Her right hand clutched a filmy white microprint which she was shaking in his face. "By God," she whispered

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hoarsely, "there's a maniac at large, a stealer of memories—a killer of souls!"

Governor-Mayor Gray leaned back in his swivel myo-chair, the signal for the ultrasonics and the microvibrators to kick in and start relieving the muscular tension brought on by his visitor's histrionics. As welcome warmth and vibration began to assuage his backache, Gray smiled. HCLU didn't like it when he smiled; then again, she probably didn't like anything.

"Don't patronize me, Mayor-Governor. Keep your goddam silly smile to yourself." The desk creaked audibly as she took her weight off it and stood with the microprint held high. "Somebody out there, probably a conspiracy of the O.R.'s again, is stealing the minds and memories of your citizens and it's your duty—your freeqing *job*—to find them and stop them!"

Gray contemplated her tirade, smiling again for effect. "It's *Governor-Mayor*, Ms. Honecker," he corrected. "Now, you're telling me that two hundred persons, DD's—"

"*Domicile Disadvantaged*," she smiled sweetly.

"—People without homes, street people," Gray continued without pause, "*the homeless*, I believe they were once called—all these persons formerly living on the streets, on welfare or by begging or mugging—"

"Statistically immaterial, unprovable, and not at all relevant," HCLU retorted.

"—and otherwise gaining daily sustenance from the sufferance of their fellow citizens—"

"Legally entitled to live peacefully wherever they wish regardless of lifestyle preference."

"—'without working,' you mean," Gray concluded. He had long ago lost the battle to clean the streets of vagrants, largely because of the efforts of his opponent here, although his drug clinics had kept the DDs down to a few thousand. "Two hundred of these people have now turned up outside New Columbia, some with new identities, most with little or no memory of the DD existence?"

"Exactly, Mayor-Governor," HCLU said, emphasizing the incorrect title sarcastically. "It sounds to me like the Old Right is trying to stage a comeback, utilizing behavioral modification, supplying drones for the hypertech industry salt mines." Gray cringed at the comparison. Hypertech was burgeoning in the neighboring states to the north, and those "drones" had the training equivalent of several old-style Ph. D.'s—with salaries to match. "Let's take the case of this one poor man, one Jorge McHenry."

Grudgingly, Gray accepted the filmy microprint, slipping it into his wristcomp. He frowned as the contents scrolled past the display volume. Damn, had this womun gotten hold of police reports? He'd always suspected that his office communications and those of the police department were tapped. Hell, probably the whole city government, since he wasn't allowed to use tax funds to clean out viruses or bugs or worms or bees or hydrae or any of the new

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compucritters the hackos kept coming up with. No telling who knew everything, he sighed silently. Maybe with a hacko net and a good enough Developing Intelligence program, the HCLU was keeping track of all of N. C.'s business. He hoped their D.I.'s weren't as good as the one the Creative Anarchists had put together for him, but he wasn't about to put Duke on the problem just yet, there was too much else to be done. Undoubtedly, if Gray were to uncover leaks in the city-state computer system, his enemies in Congress would hold it against him, not praise him for it.

However HCLU had obtained her information, she had done his DI system one better. She'd actually found one of the former DDs, interrogated him with HCLU psychs and soches and meds, and documented the man's entire life history, then had the experts speculating on his . . . his . . .

Change, Gray concluded. *Personality change.* He whistled as the med data crawled across. Shit, not only personality changes, but pret' near a whole damned new body, too. "McHenry's schizophrenia is cured, his drug addictions are gone, the whole spectrum of mutAIDS viruses has disappeared?" Gray shook his head in amazement. He glanced up from the wristcomp to look at HCLU. "The man's now living in a hyperscale apartment, holding down a hypertech nanomachinist position in Gaithersburg?"

"Yes," HCLU hissed, "most of the DDs have reported to one of the Gallium Glen hyperfirms in Maryland; some are up in Pennsylvania." Gray wanted to shrug; so what was her problem? Those companies had been desperate for techno-help ever since Congress slammed the door shut on immigration in '05, when the Euro-Mart collapse threatened to flood the States with technicals. The *All for Americans!* job program had been strangling hypertech companies ever since; no more Germans-on-the-cheap, but no educational improvements in the U.S. to help fill the job market openings, either.

Something was wrong here; Gray's political instincts told him he was being hoaxed. *Who gets?* he wondered. *Who pays?* He stroked the wristcomp off and, standing, handed back the datafilm microprint to the civil rights advocate. "So what's the problem, Ms. Honecker? Seems our man McHenry is doing all right for himself now." Irritated by the fantastic line the lawyer was spouting, Gray riffled through stacks of micropapers on his crowded desktop, finally retrieving a translucent rectangular tube about two centimeters square by ten centimeters long.

"Ma'am," he said flatly, watching her cringe at the honorific, but by God, two could play that bastardly game, "this nanofile holds the med, soche, psych profiles of all the home-state criminals that New Columbia has any record of, from misdemeanors to murder." He waved the tube under her nose, as if hoping she could smell the foul content of the data itself. "I know that most of these people suffer from neuroses, psychoses, socioses, and outright debilitating physical problems. Now, if you can

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just find out for me just what it was that the Old Right or anybody else did to our Mr. McHenry, former DD and now tax-paying hyper-techo, please let me know right away. I've got a few hundred thousand more just like him who need the same help!" He knew he was wasting his breath, knew the womun was hysterical, spouting another of the crazy conspiracist theories the HCLU tended to drag out when they had a slow day.

"You just don't get it, Mister, do you?" she spat out in the old, old cliched curse, "Somebody has changed their minds, their *lifestyles*, without so much as asking them! They had a *compulsion* to go to work for companies, without being recruited! How can you sit there and, and—" Losing control, HCLU walked toward the door, shoulders hunched. Turning to glare, she said with venom, "Mayor-general-governor or whatever the hell you are, Mr. Eldon Gray, let it be known I tried to reason with you." Gray knew she was playing to the built-in recorder holocams but that was her right; he just wanted her out of his office. "If you have the audacity to prescribe or condone unknown, unproven, and illegal behavior modification techniques—against the wills of helpless citizens, I might add—I'm sure the press will want to know."

Gray waited for her to stamp her foot but was spared that bit of maudlin overacting.

Before she stepped through the door, though, Gray ventured one last parry, playing by her own rules. "And what about McHenry, Ms. Honecker? Have you asked *him* which life he prefers?"

"You of all people dare to ask such a question? How ironic that I'm Whyte and you're Blaque," Honecker hissed through clenched teeth. "Wasn't slavery abolished over 140 years ago, Mister *Freeman* Eldon Gray?"

As the door slammed, a shaken Eldon Gray found his chair and tilted it back. Whether it was coercion, or even slavery, he was convinced the DD's and N.C. were both a lot better off, regardless of the motives of the unknown "criminals." At times like this he wished he had a vibratory attachment for his aching forehead, too. Through the throbbing, thumping vessels in his head, he wondered where the hell Lavender was and what the hell he was doing. It had been a whole day and all he'd heard was a cryptic audio report from his investigator, something that promised to make as little sense as Honecker's hallucinations. He wanted some real facts about this case, not a wild womun's sci-phi ravings.

Twenty-four hours to the minute after their last meeting, Detective Lieutenant Lavender called in to the G-M with a request for a scrambled video channel. "You've got it, son. Go ahead, Lieutenant Lavender," Gray said anxiously. He hoped the man had something concrete; half the time was up before the office recorder disks automatically downloaded into the networks and any citizen could access the minutiae of the G-M's daily

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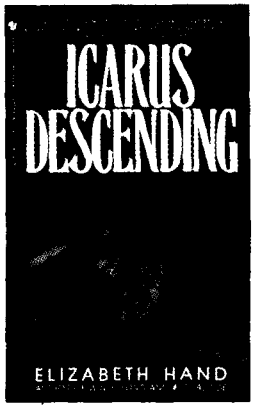
–*Locus*



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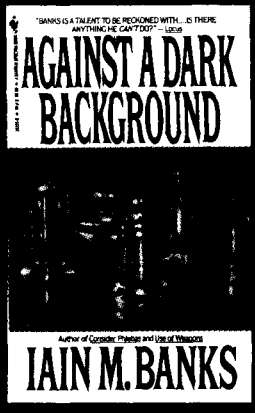

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office life. At least they haven't got them in my home yet, he thought. I'll bet Congress would love that. Too bad we can't reciprocate the privilege on them.

"Governor-Mayor, sir, my full report to you will be crypto'd and squirted through now. Better turn the volume down." Gray did, waiting until an all-clear light told him the transmission was complete. "Sir, I can summarize for you what I've found out. I've got one suspect, a short Caucasian male wearing a dark overcoat and a large, floppy hat, like Lamont Cranston in the old flatfilms." Gray's wristcomp displayed a sidebar comment while Lavender's image spoke: *LAMONT CRANSTON: A CHARACTER IN A 20TH CENTURY RADIO SHOW, COMIC BOOK, AND MOVIE, "THE SHADOW." HAD "THE POWER TO CLOUD MEN'S MINDS."* He vaguely remembered the character, sometime way back in musty memories of ancient media.

"I'm doing a stakeout last night, as a DD, on 12th near the Triangle Metro. This one guy comes up to me, hands me fifty thousand in gold quayles, and before I can get up and get him, he speeds off in a Cadillac USport Electric. Spells Georgetown, Collectivist-Liberal Party to me, Sir." It fits, Gray nodded. The *Americans First?* Collies typically gave their donation money anonymously on the streets. But who the hell would have that kind of money to give to DDs? And more than that, how would money alone change a personality, not to mention heal a rundown, drug-ridden body? The wristcomp showed over two hundred fifty DDs gone from the streets now; somebody was working very hard on the DDs. At this rate . . .

Gray caught himself short. At this rate, they'll all be gone in a couple of weeks and DDs will be a thing of the past! That is, *if* they were just leaving town, if HCLU's reports had anything to do with reality. But what if HCLU was anywhere near correct, though, and the DDs were actually being reformed by somebody? Was that really bad, like Lavender said yesterday? Or was it really stealing their minds and souls, like Honecker thought? Was the effect permanent? *How* was it done? They must have some system to kidnap the DDs off the streets, then forcibly brainclean them. But that one the HCLU had data on, he was gone just two days! A blank there. Finally, politics, that pragmatic expression of human desires, intruded into Gray's excited chain of thought with the ultimate political questions, a balanced equation really:

Who gets? Who pays?

Lavender continued, "Something else, sir, I need to tell you. Something's happened to me, sir, and it came on right after I met the Shadow guy. I don't know if it's a drug or what, but—you wouldn't believe the changes in me, Mr. Governor, Sir. I've become so calm and happy that it's almost frightening. My nightmares are gone, I didn't even want a drink last night or this morning, and my terrible memories—I can call them up and look at them, and they don't hurt anymore. It's just incredible."

Gray sat back, astonished at his detective's confession, as much for the

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man's demeanor as for his report. Totally unlike Lavender, such disarming innocence. Shit, so Honecker was right, it wasn't an HCLU fantasy story! He really couldn't believe all of that just yet, but this was too coincidental. He'd intended to have Lavender check out the HCLU reports just to quash them for the media, but now—.

If it weren't all a gigantic hoax to have his, Gray's, job, then Lavender, too, had been "visited" by the same—*gift*—like the two hundred and growing DDs. But how did they do it without taking him away for treatment? *Drugs!* Lavender had said. That had to be it! But where, how? "Detective Lavender, stop for just a minute. Listen, is all this data in your report?"

"Yes, Governor, it is."

"And you've solved the DD disappearances? Cleared it all up?"

"Yes, sir. I've found all the missing DDs. Most're in Maryland, some up to Pennsylvania, the Gallium Gulch region, in the hypertech factory industrial parks. And you wouldn't believe it, but they're all cleaned up like me and—"

"I believe it, son, you don't know how much I believe it. But who did it? And why?" *And how, man?*, he didn't add. That, he was afraid to know, afraid of his own weaknesses.

"Sir, I'm afraid I don't know who and how just yet, but my DI is searching all the possible connections. You know, Georgetown, the Collie Party, the Old Righters, the Poppies, the works. Gotta be one of them. Just a matter of time, we'll have him. Or them. Or whoever."

Gray breathed deeply. "Fine. Now, yourself, you get out to the NIHT over in Maryland right now and get yourself a priority CompScan. Full body, the works. I'll authorize an account right now. A state ambucar will pick you up in five minutes."

Lavender gasped at the other end of the connection. "Of course, Governor, sir, but the expense—I feel fine, I really feel great, sir. The best."

Gray was already stroking in the codes to get the N.C. Care Unit on the way to the detective's house and the NIHT staff prepped for his arrival. "Lieutenant Lavender, consider yourself field-promoted as of right now." At the detective's quizzical half-grin, he explained further. "Yeah, I'm not the chief anymore, so I can't officially do that." He winked. "So, within my legal power as the governor-mayor of New Columbia, I declare that you are temporarily on assignment with the governor-mayor's security office as of right now, with the temporary rank of inspector-major." He'd always intended to start such a department and now seemed like an appropriate time. The budget authority had been available since provisional City-Statehood, but until now he had always just signed the funds over to the police department.

"Also, consider yourself on sick leave immediately, with five weeks vacation time to follow your hospital stay."

Lavender accepted the somewhat irregular promotion with surprise, mumbled a slight complaint about wanting to finish the case, thanked his new direct superior, then broke the

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connection. Gray was worried; his own man said the DDs were clean and trained. So HCLU was right, somebody was forcibly changing the DDs. What kind of person would change another without his permission? The old Reds had tried the most brutish behavior modification methods for most of a century, but they were just an unpleasant memory now. The last batch of coercive bastards who'd tried anything similar had been the radical Isfund psychoterrorists, and now the few survivors of that abortive movement were in hiding or bankrupt. Most of the world was rocking along fairly well without any ideology other than democracy and rational consumerism. True, the world still had problems caused by economic hardships, social breakdowns, and drug violence in many places.

Given the choice, was it better to be down and dirty from your own free will, or a balanced, healthy citizen by coercion? Gray considered that one carefully. At first, he didn't think he knew the answer, but further reflection brought the obvious deduction: as a child, you're not given much choice in your education, your programmed behavior modification, either. And if the *drug, brainwashing,* whatever, was forcing the DDs to accept the equivalent of moral and technical training, wasn't that the same thing? And wouldn't the DDs have chosen the change, given the choice? *Should* they be given the choice?

Thankfully—hopefully—Gray wouldn't have to make such a choice for himself or for anyone else. But obviously somebody out there didn't mind making those decisions at all.

What is their motivation? And how do they do it? Gray smiled at his own thoughts, idly stroking up a display of education expenditures in the City-State. How indeed? The N.C. public school system, when it worked at all, wasn't nearly so effective....

"Crypto channel, Governor-Mayor?" the full screen image asked. Gray saw four people, presumably NIHT staff, staring somberly out of his home display wall, directly at him. He sighed and pushed away his cup of hot coffee from the holocam's view. His caffeine use would be noted by the doctors, and mandatorily reported to the media. Officially and socially, all forms of addiction were frowned upon in New Columbia.

"I'm at home, Doctor, so there's no office recorder here. Strictly off the record. What about Inspector Lavender? What have you found?"

"Mentally, psych, soche, physically, the man Lavender is in excellent health. In fact, holistically, he is one of the most perfectly balanced individuals we have ever examined." The doctor waved her hand, evoking a holo display of Lavender's body, where colored lights illuminated the organs being discussed. "Compared to Detective—er, Inspector—Lavender's last physical checkup a year ago, he has undergone nearly miraculous remissions. Scars on his body—from childhood fights, he tells us—are nearly completely invisible. More remarkably, his eyesight is now 20/20,

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his incipient alcoholism has vanished, his liver seems to have repaired itself, and greenstick bone fractures—" The doctor stopped as someone in the background interrupted her. "—from an abusive childhood, the soch says, have reset themselves. There is also a slight decrease in testosterone level.

"But, more importantly, at least to the psychs and soches, is that Lavender has no more desire for inflicting violence on himself or others. He has no craving for alcohol or tobacco. His S.O., Ms. Yulia Zakorodsky, confirms this. In fact, she herself has undergone a transformation of the same sort and we wish to continue our investigation of both of them. There have never been cases like this."

"Hold on, Doctor," Gray broke in, "New Columbia doesn't have the resources for your experimentation at our expense. I just wanted you to have a look at my detective, a man who may have been wounded in the line of duty. His S.O. is not my concern."

"Understood, Governor-Mayor Gray. We will CompScan her at our own expense, if she will allow it." Gray shrugged. He wondered aloud if the *change* mechanism, the drug, was spread by sexual contact. The doctors were skeptical.

"As far as anomalies, we have identified an extremely small unknown virus in the blood of both patients, Governor, but it's almost as if the thing is destroying itself before we can get a look at it. We'll keep trying to isolate it, though."

After agreeing to keep the G-M informed, the NIHT staff broke contact, leaving Eldon Gray even more puzzled. He decided to call up his one secret weapon, one not yet uncovered by the *verch* media. His own evolving Developing Intelligence, a software system growing for nearly ten years, with a hardware technology known only to a few. "Duke, my main, it's the chief."

A neural contact between Gray's wristcomp and his skin tingled momentarily as his voice pattern and physiological parameters were monitored and verified by the DI system. Contact was established. "Yessir, Chief, Duke here," the voice drawled in an imitation of a last-century cowboy star. "What's the scene?" Only Gray could hear the neural message, and his responses were subvocal. Mentally he thanked his old libertarian friends of the I.C.A. for coming up with the on-board nanoelectronics that made "Duke" possible. Who'd ever notice some small dark "tattoos" on his ebony skin anyhow? Amazing, he thought, what the undergrounders have developed that they only sell to their friends. A decade of economic warfare with the PacRim countries had kept many of the best advances in nanoelectronics proprietary. What reached the shelves of techostores was years behind state of the art. Patents and copyrights were a thing of the past; outright secrecy and hidden circuitry kept mercenaries and predators from "reverse engineering" one's technologies. Gray heard it worked well for both sides. Some things were too important to sell to just anyone.

Gray walked around his room, out-

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lining the datascan he wanted Duke to do, then went to bed. As he slept, his onboard nanocomputer system, constituting "Duke," accessed the house electronics, the homecomp, the fiberoptic network, and all of the police and personnel files and databases legally available in N.C., neighboring states, the Library of Congress, and the old CIA and NSC files. Some other databases were available simply because of Duke's intimate connections built up over the years, or by the multiply-pronged search and infiltrate routines called *hydrae*. By the time Gray awoke, his "nanoelectronic subconscious," as he called it, had finished the requested job and downloaded it into his ever-present wristcomp.

Upon awakening, Gray groggily looked at the wristcomp display. The macro-memory showed a short message from Inspector Lavender waiting; Duke's report was also resident. Gray sat in silence as Lavender's recording spoke. He thought the man sounded a little upset for one so recently purged of all negative emotion.

"G-M, Yulia and I have got a clean—*superio* clean!—bill of health from these guys at NIHT. But I've been hackoing the case a little bit more, and have some data I've gotta dump face-to. With your permission, I'll come tell you before Yulia and I leave for Caribbea, OK?" Gray nodded and stroked out a video acknowledgement for Lavender.

With his first sip of morning caffeine Gray had just started to review Duke's pieces of the puzzle, when the homecomp warned him of a visitor car. *I'll be damned*, he swore under his breath, *why didn't they wait*— The front driveway access monitor warbled. The video showed two people, a man and a womun; both looked like the background types in yesterday's NIHT call. "Come right in, folks," he replied wearily, "the governor-mayor's house is always open to the citizens. Even of neighboring states." He gave orders for the armed guards on the front porch to let the delegation in through the perimeter defense fence. Within a minute he met them at the door.

"Excuse me if I don't shake hands, folks, but I'd rather keep my wits about myself, if you don't mind." His guests jerked their heads to stare at each other, then back toward him. Gloved hands quickly found overcoat pockets.

They were finally seated in the governor-mayor's reading study, apparently caught off guard by the mode of his greeting. "Er, Governor-Mayor Gray, sir, we—"

"I think I know why you came," Gray oozed, "and I'm not sure I like it. What the hell are you doing, and why?" Knowing scientists, he knew he'd be told the *how* very soon.

"I'm Dr. Michael Coffey, this is Dr. Lisa Hofer," the man said tensely, his hands shaking nervously. "We came to discuss the further findings on your Detective Lavender."

Sure, Gray thought, just keep your hands to yourself, man. "Go ahead, then. Too bad you didn't just call me, or have the good manners to make an appointment."

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The visitors looked stunned. "But we did! You did! Late last night, when—"

Gray realized he hadn't read Duke's report, hadn't even looked at today's appointments display. His DI had simulated his voice and got these people here at 0600 for God knows what. He often let Duke handle routine appointments; it beat a human secretary. This time, though, it was just too damned early! "I'm sorry, you're right, Dr. Coffey. I must've let it slip my mind. So many things . . ." He let the sentence die off as he yawned. Sipping coffee helped him break the embarrassing moment. He could tell both doctors were making mental notes about his caffeine addiction, and that the media would know tonight. So what, it's minor compared to—

"Nanomechanisms, Governor-Mayor, we found nano-devices in both Mr. Lavender and Ms. Zakorodsky." Choking, Gray nearly spat out his mouthful of hot liquid.

Before Gray could stop coughing and catch his breath, Coffey continued. "Fortunately, they were benign, sir. In point of fact, we think they were the mechanism by which the two people—Lavender and Zakorodsky—were transformed into extremely healthy individuals." Dr. Hofer indicated her agreement.

"But I thought they—all nanoes —were outlawed for internal medical use, after the North African thing." The doctors nodded; after Libya's disastrous, abortive attempt to leapfrog EuroMart militarily some years back, there had been a voluntary worldwide halt in research using invasive, autonomous nanomechanisms. Parts of that devastated country were still under total quarantine and probably always would be. As well as a lot of French vineyards, he sighed.

Coffey pursed his lips. "Nothing ever really totally stops research, sir, you know that. It's kept out of the public eye, of course. But somebody out there has advanced the technology incredibly beyond anything we thought practical."

"But it wasn't impossible, then. Who could have done it?"

Hofer shrugged. "Anyone with competent nangineers, topflight fablab facilities and years of uninterrupted funding. Certainly not anyplace subject to political vagaries like NIHT is." Gray nodded; the recurring budget disasters barely kept any public-funded, non-directed basic research lurching along anywhere.

"The Pentagon?" It was a weak attempt at humor on Gray's part. Half of that physical building was still abandoned from the time, years ago, that the military budget was zeroed out by a radical coalition of Collies and Poppies. But it was all he could think of to contribute at the moment. Damn, he wished he'd read all of Duke's report before these people came! He could opt for Duke to give him a silent verbal output, but he didn't want to chance the distraction while he had visitors.

The doctors ignored his speculation. "As to how it could be done, we have theorized that these nanomechanisms sample the DNA molecules, evaluate how the configuration

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would evolve into a human body, then correct those deficiencies they find."

"How about birth defects, that sort of thing?"

Coffey glanced at Hofer, who shook her head. "We don't know anything about that, yet. What we found in the brain is the most interesting, though." Gray put down his coffee mug and leaned forward to listen. This was getting close to mind control. As a politician he was extremely interested; after all, he'd been practicing a form of mind control on his constituency over the years, and quite successfully, too. But doing it from the *inside*, without the patient's —voter's?—approval. That chilled him all the way down.

"We theorize that traumatic memories create identifiable chemical potentials where the synapses attach to the neurons in the brain. We further theorize that these nanomechanisms swarm through the physical brain, locate and identify these potentials, and discharge them in a benign fashion."

"Which means in English, Doctor Coffey?" Gray inquired, cocking his head.

"Which means that the emotional content of the memories is effectively erased, that the memory itself, though still resident, no longer evokes emotions upon the conscious mind's reviewing it."

Gray was totally taken aback. "And you know this, for real?"

Hofer spoke, "Not until we take cell samples of the brains, and we can't do that now, not with living patients. We assume this mechanism as one alternative among many, but the model is primarily based on the testimony of Detective Lavender and Ms. Zakorodsky."

"Right, Lisa," Coffey said. "Governor, Inspector Lavender had suffered from childhood abuse—broken limbs, knife fights, sexual abuse, the works." Gray nodded. Right. No surprise, just a child's life in old D.C. He had undergone similar rites of passage. Thousands of his brethren had not made the passage, had been given other rites, final ones. "And though he can now recall these events, he no longer *feels* them. He can sit back and view them dispassionately. Learn from them. Not be a victim to them any longer."

"And the Russian womun," Coffey said, "Yulia. She went through the horrors of the EurAsian Wars. Now she speaks as calmly of those years as if she were watching a holo story. These people are truly liberated from their traumatic memories, not merely braincleaned. They prefer it this way. Your Lavender said it was 'All gain, no pain.'

"I just wish we could keep them longer, study them more, find out in detail what has happened to them."

Gray ventured, "And try to duplicate it? Illegal nanoes?"

The doctors once more did their Let's-look-at-each-other-and-then-at-the-G-M routine. Coffey cleared his throat. "We thought, sir, that given New Columbia's er, *liberal* views on drug administration, that with your permission, perhaps we could open an experimental clinic here, qualify the nanomechanisms as a new drug,

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a new molecule, so to speak—"

"And do illegal nano research in my precariously provisional City-State?" Gray stood and steepled his hands. He winked. "Why, doctors, what makes you think I'd be a party to such a thing?"

Gray smiled broadly, shaking the hands of the surprised NIHT doctors. "You can't keep your two patients any longer, right? You need more cases to investigate, right?" Open-mouthed, the two doctors stared at him, this time without looking at each other first. "What if I told you where you can find two hundred more?"

Duke had found nanoes, too, but it took the G-M over an hour to read and understand the D.I.'s all-inclusive report. The bare technical data was all there: with a little bit of direction, the Developing Intelligence programming had laid out sources and sinks of continuous funding for molecular research, drug testing, defense contracts, Department of Technology proposals and grants, National Technology Foundation activities, all the continuous on-line technojournals. The data pointed to a small, secret group somewhere within a government, maybe even in New Columbia itself. But something was lacking, and Gray knew what it was—the human element. Only humans were screwed up enough to pull non-linear magic out of vast arrays of sterile data structures.

Take his own irrational thought processes: When his NIHT visitors had shown up, he thought they were part of a renegade group of free-lance social reformers who had decided to clean up the streets of New Columbia all by themselves. Until the NIHT'ers told him otherwise, Gray had been convinced that only drugs could effect such changes in people's behavior; he had completely forgotten autonomous nanotechnology, since it had been out of the public eye for some years now. Luckily, Duke didn't know from molecules and anything small enough to enter the human body showed up in his datascans, then was analyzed and identified.

So it had been nanoes all along. But if those NIHT folks weren't the perpetrators, the "perps," who were? He was sure the linkages were somewhere there in that mass of Duke-data, but the rational, dispassionate viewpoint of a soulless Developing Intelligence was simply too smart to find the loose threads. True, Duke stated flatly that the Cadillac, the Shadow costume, all that, were simply amateurish attempts to throw off the police. Unable to correlate an automobile or an outlandish costume with anything else, Duke just suppressed the anomalies and the real data stood out starkly.

But Gray still needed human bad guys, human means and human motives. And for those, he was praying that Inspector Lavender would come through before leaving on his five-week vacation. Gray smiled, thinking, *Finances, that's where the real power is: Who Pays? Who Gets?* Somewhere, down among the dollars, Lavender would solve the mystery. Gray's Two Laws of Politics would prevail.

He was not disappointed. "Gover-

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nor-Mayor, sir," a familiar and welcome voice announced through his wristcomp, "Inspector Lavender is at the door."

"Come in, Jay," he answered in a low voice, "I hope you've got something for me." A knock on the door, and the tall inspector entered. At his side was a little man in costume.

"Hello, Governor-Mayor Gray, sir," said The Shadow.

"I'd better tell you how this thing worked, G-M, sir," Lavender began. "After my experience as a DD, when I became a new man, so to speak, my mind was clearer than ever, I was really hot! So when you told me to go out to NIHT, I was afraid I might get 'cured' and wind up as bad off as I was before. I had to solve the mystery fast. I didn't want those dox to un-fix me, good as I was feeling, so I needed to know right away what was going on. That's when I sent out a couple of mega-hydras to check out the dataflows."

He smiled broadly, revealing perfect teeth and gums. Gray could see that the usual protobac stains were gone. "Things got real strange, real fast. Had a few datajousts before I finally cracked a really tough opponent. And that's when I met your ol' buddy, the cowboy." Lavender stroked his own wristcomp.

"Howdy, pilgrimos," Duke's voice said aloud. From Gray's wristcomp. Jay's not only a damned good hacko-tech, the G-M concluded, at once sad and relieved his DI had been compromised, he's the freeqing best!

The Shadow sat quietly as the new inspector regaled Gray with his prowess as a hacko. "With my hacko resources and ol' Duke's enthusiastic cooperation, my hydras tracked down and cross-correlated just the data I needed, sir."

"You found the perps?" Lavender nodded. "And the brains behind it all?" The inspector nodded slightly, again.

"Yes sir," he said slowly, almost defensively, "I found who made the nanoes, and why. And the brains behind it all. I have audio recordings that tell the whole story."

"Who set it up?" Gray's voice began to rise, his hands forward, pleading. "Who did it?"

Lavender glanced at The Shadow, back to his boss. Taking a deep breath, he said, "Why, you, sir." Quietly, without emotion: "*You* did it."

Out of breath with shock, Eldon Gray, Governor-Mayor of the provisional City-State of New Columbia, collapsed back into his chair. The myo-sensors stayed quiet for once, not programmed to work under such an extreme overload. "What kind of joke is this, *Inspector* Lavender," he shouted. "And just how the hell did I do this, and why, for God's sake, don't I know about it?"

Lavender and The Shadow were on their feet instantly. "I'll—be—damned," the taller man said slowly, "he really *doesn't* know what he did?"

The Shadow spoke finally, breaking the embarrassing silence that followed. "But it was *his* written orders, *his* voice—"

Lavender rubbed his chin for a few

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seconds and then slapped his hands together. "By God, that's it! *That's* why I couldn't piece it all together, I—"

Eldon Gray held up his hands palms out and shouted, "Would someone please tell me what the *hell* is going on?"

"As you wish, sir. Now I can tell the whole story." All three humans dropped their jaws in surprise. The voice was coming from all three wristcomps, in a familiar John Wayne drawl.

Duke was speaking.

Over the years of its existence, Duke told them, it had absorbed Gray's rules of politics and personal behavior as gospel, as operating guidelines to determine the direction of its development. During that time, as the staff of the Institute for Creative Anarchy added more and more external functionality, allowing the DI to roam the datanets and the worldwebs, Duke naturally adapted these new talents to carry out its master's wishes, to align reality with Gray's vision. And so it had happened with the nanoes and the DDs.

"Here is your own voice, sir," Duke said.

Gray heard himself say, with rising emotion, "I will do *anything*, anything in my power, to keep the DARs open, to save the young men and women of the District!"

"But that was over ten years ago, Duke," Gray protested, "you weren't even around then."

"You programmed me to research all past and current records, G-M, sir," Duke replied without emotion. The three men all chuckled.

"Go on, Duke," Gray commanded, still astonished at his own creation.

Gray's wristcomp hummed with notice of an incoming display. "You see on your screens, gentlemen," the DI went on, "the authorizing legislation—the executive orders—that enabled the financing of special DAR research facilities for the express purpose of 'extending the effectiveness of DAR treatments, regardless of methodology.' "

Gray nodded. Eight years ago, that had been quite a controversial piece of work. "But that was mostly just political ups-personship, Duke; I had to face down some recalcitrant drug-dealer-financed city council members. I didn't mean anything serious by it, I was just pushing for more funds."

Duke was silent for a moment, then continued, stubbornly it seemed to Gray. "The sentiment was consistent with your daily utterances, sir. And, may I respectfully submit, it was official legislation?"

" 'Watch what I do, not just what I say?' " Lavender murmured, echoing another familiar Gray-ism. Gray flushed. The other men just looked at him. Duke's narrative went on, spinning out the whole story.

By Congressional mandate, directed funding from NIHT appropriations supported Gray's own creations, the New Columbia Drug Administration Relief centers. Duke's net manipulations had creatively siphoned other funds from many sources and kept them successfully

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hidden, financing a small cadre of researchers who had gone on their merry way for eight years now, untouched by the political wars on the Hill, protected by political agreements that Gray had instituted a decade before, during his crime-cleanup days. "Chief, you keep getting results, we'll keep the money coming!" Congress had said—and Duke had it in writing and an audio recording. Using Gray's voice, and sometimes his image, Duke had given the DAR research team the same message.

Duke had learned how to massage finances when Gray used the DI to cobble together a few "black budget" agreements for other projects desperately needed by the city but politically unpopular. Gray heard a recording of himself asking the DAR scientists to find new ways to reduce drug addiction, and to help the addicts find better lives. "Get wild, get unreal. Just get me answers," he'd told his people. *You better watch what you ask for*, the old saying resonated in his mind, *because you just might get it!*

Gray brought his attention back from his own musings to Duke's revelations. From the looks of the two men, he'd missed something the DI had just said. In his best political comeback he asked, "But why did you keep all this secret from me, Duke? You knew I was searching the data for clues about the DDs. I could have helped you."

In reply, his own recorded voice answered, "I don't want even the appearance of scandal in my administration, folks." (He recalled that speech, to a convention of D.C. police officers, years before.) "I don't want to hear of anything not strictly within the rules. Not even a whisper about wrong-doing!"

"Naturally," Duke broke in, "I carried out these express orders. I instituted a program that would have been unpopular with the public and the media, because you so wished. And, as you wished, I did not communicate these arrangements to you." Duke paused. "Until now, until you directly ordered me to tell you."

"Wait a minute, Duke, you had to know what I was looking for. How about when I did that scan last night?"

"Governor-Mayor sir," Duke replied a gentle tone, "last night you were highly excited; you were in no condition to hear the news. You really didn't *want* to hear it. But when you made request a moment ago, your physiological monitors indicated you were ready and willing to know the truth."

Frowning, Gray pointed at the myosensors in his chair. He'd forgotten the things were wireless and continuously monitoring him. And he had the same kind of sensors all over his house. Duke knew him very well; literally better than he knew himself! "So, Duke," he whispered hoarsely, "you followed my orders literally, and you told me only what you knew I actually *wanted* to hear."

"Yes, sir," the D.I. said. "Like you've said on many occasions, 'There is Truth; and there is Political Truth. It takes a Politician to know the difference.' "

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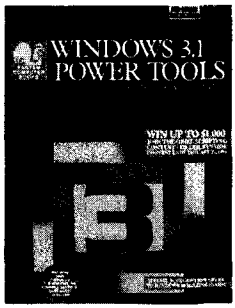

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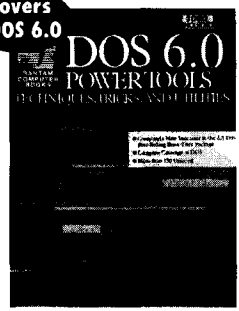

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Lavender and The Shadow looked sharply at their elected leader. A shamefaced Gray could read their common thought: In a political environment, even a true innocent learns duplicity.

Duke's soliloquy finished, a chastened F. Eldon Gray commanded the DI to remain silent and deaf until he re-actuated it by his stroked wrist-comp command. The three humans sat nervously back in their chairs, shaking their heads. "It was Duke who let me in," Lavender groaned, "and here I thought I was the best hacko-tech in the District. Outwitted by a damned DI! Don't let this one out, G-M, I couldn't live it down."

Governor-Mayor Gray leaned back into the caresses of his myo-chair, smiled broadly and steepled his fingers. "So my silicon companion took my desires, authorized himself with actual legislation, then funded and directed a research program just like I would have done myself. Amazing, just amazing."

"The Shadow" spoke, "Our fifteen-person R&D team of nangineers was totally taken in. We knew it was a hush-hush job, but we thought we were following your written, verbal, and video instructions all the while, even down to this strange mode of dress while doling out the dough." He shook his head, flapping the brim of the ridiculous hat. "And passing out the nanoes to the DDs by using money, that was a brilliant stroke. Even when I gave the quayles to Detective, I mean Inspector, Lavender, your voice—Duke's impersonation, I mean—told us where he would be, how much to give, and even his name."

Gray said, "The hat, the costume, the fancy car, I can see where Duke would do that. I used to teach rookies that crimmers project the absurd, the strange, to distract law enforcement from their actual appearance, their real activities." Then he forced himself to look out the window, toward the Lincoln Memorial.

The pain, as always, returned, an unwelcome yet dependable visitor. For the ten thousandth time, explosive bullets from the last of the druggers, intended for him, claimed Zerah on the bloody steps of the Lincoln. He turned back to The Shadow, thinking, *Can this man really "cloud" my mind? Is it possible to—to forget this pain?*

"You've handed out quite a lot of this—tainted—money, my little friend?" he asked rhetorically, finally turning to look at the costumed nangineer. Lavender broke into a grin and winked at his boss.

Surprised, the little man said softly, "Yes, Governor, sir. But I was the very first to—to *use* nanoes. We all did, eventually, the whole team, all fifteen of us nangineers. Then we treated our families, all voluntarily. Fifty people, over a one-year trial period. We were more careful than the Federal Drug Administration would have required, dealing as we were with ourselves and our loved ones; but under an obscure statute you—Duke—quoted, we are quite legal, 100 percent aboveboard. It was only after those successful tests that you—that Duke—gave us permission to start healing

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the DDs."

"What about the techno education?" Gray asked. "What if they didn't want to run a nanomill?"

"Sir, if you don't *need* any more training, then we give you some that are just for healing. Your body and your mind." The Shadow smiled. "For the DDs, it was a matter not just of healing them, sir, but of quickly getting them back into society. A healed mind and a good body aren't going to help you much if you can't find a way to sustain yourself, earn some self-respect. And some money. Maryland and Pennsylvania need lots of nanotechs and pay them quite well. You know how they've been recruiting people since the school systems all but collapsed; the hypertechs'll take anybody off the street, but they apply their own aptitude and skills testing. If the people pass, they get a job. No way they can trust any diploma any more.

"So far," he said with evident pride, "every one of our 'graduates' has passed with flying colors." He shrugged. "We in the nangineering group felt it was a good solution. And it was expedient to program the nanoes to educate the DDs with the best training, then cause them to want to go where they would be useful and happy." His tone implied he was wondering why anyone would be concerned. "Eventually they would have applied that new training, anyhow. But why serve up trauma? We just eased their transitions a bit, that's all."

Gray nodded. This one had no trouble at all making life-changing decisions for others—*who* should be educated, *where* they should live, *what* work they should do. He shook his head, sighing. He was going to have a hell of a job working on concepts of ethics with this team of techos. Maybe even call in the HCLU civil rights experts for some inputs. Perhaps develop a nano treatment for ethical behavior assurance? But for now. . . .

For now, that 'healing of mind and body' sounded quite good enough.

"The nanoes work very well, sir," the man went on. "The unneeded ones flush themselves out, the maintenance ones stay. No side effects. Except health, inner peace, and a new emotional maturity."

"For ever and ever, amen?" Gray whispered.

"Sir, at your—*Duke's*—insistence, all of the nano enhancements are absolutely and totally reversible at any time if anyone, God forbid, would want to change back." He shuddered at the heretical thought.

Gray extended his hand, palm up. "I think I'm running a little short, my shadowy friend. Spare change, mister?"

Hesitantly, looking first at Lavender, the man reached into a flap of dark cape and pulled out a foil of gold money. He held it out to F. Eldon Gray. The Governor-Mayor of New Columbia took the filmy cash, rubbing its greasy coating all over both palms, then turned to study the silhouette of the Lincoln Memorial, framed by the gold of the setting sun.

The little man spoke again, smiling. "The view—er, of the Lincoln Memorial—from your window, should be

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especially appealing this time of day, sir. The whole team has wanted for a long time to give you back this wonderful view as a payback for all your—Duke's, of course—your efforts to discover this vaccine for the soul."

"Quite right," Gray replied as unspeakably gentle warmth spread through his body, soothing even his aching feet. A similar warmth, a semi-erotic *silkiness*, a condition of peacefulness, coursed through his conscious mind. "The Lincoln *is* quite beautiful again, after all this time."

"Governor, sir, there will be a slight elevation in blood pressure and your temperature, as the nanomachines multiply and repair your body. These symptoms will pass."

Gray nodded. The old painful memories of violent death and interrupted love were dissolving from his heart, as surely as the day was closing. But there was no night coming on, he felt, just a new kind of dawn. The right time to begin his next political move, the best maneuver of his career. He shook Lavender's hand and thanked him for his help in solving the case. "Couldn't have done it without your help. I don't think Duke ever would have let me find out by myself, if you hadn't got into cyberia, there, and forced his hand."

"Who knows, sir?" Lavender replied with a smile. "that's some kind of partner you've got. Look at what he's done. For us all." He paused. Then, "Sir, you might want to consider more two-way communication with old Duke. Like listening to him. For advice, you know?" Gray just stared at him.

The inspector took his leave, while the nangineer and the G-M remained, watching the Lincoln Memorial as night claimed the horizon. Gray calmly viewed the recurring streaks of yellow fireworks over the Potomac, where the nightly laser sniper firefights continued to destroy abandoned buildings and abandoned souls. *They need a little money over there*, he thought. *Every town could use a little more money.*

"Keep some of that clean lucre on you, Mr. Shadowman," he said to the little man beside him. "I've got a lot of congressmen I want you to meet tomorrow. In fact, I've even got a dinner date with the President and the whole Cabinet. That's real clout, don't you think?" He smiled and shook the man's hand again, giving him a heartfelt—not a political—pat on the back. "And I think all of them, the Capitol, the White House, they need a little political donation."

A sudden thought struck him and Gray grinned widely. "The politicians in this town," he said, "have always believed that they could solve problems by throwing money at them. This time, my friend, they just might be right." Gray winked at his smiling companion.

"Ain't politics wonderful?" ■

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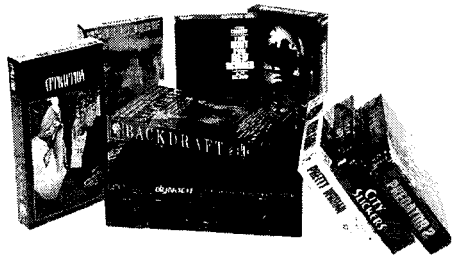

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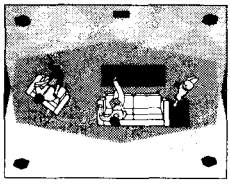

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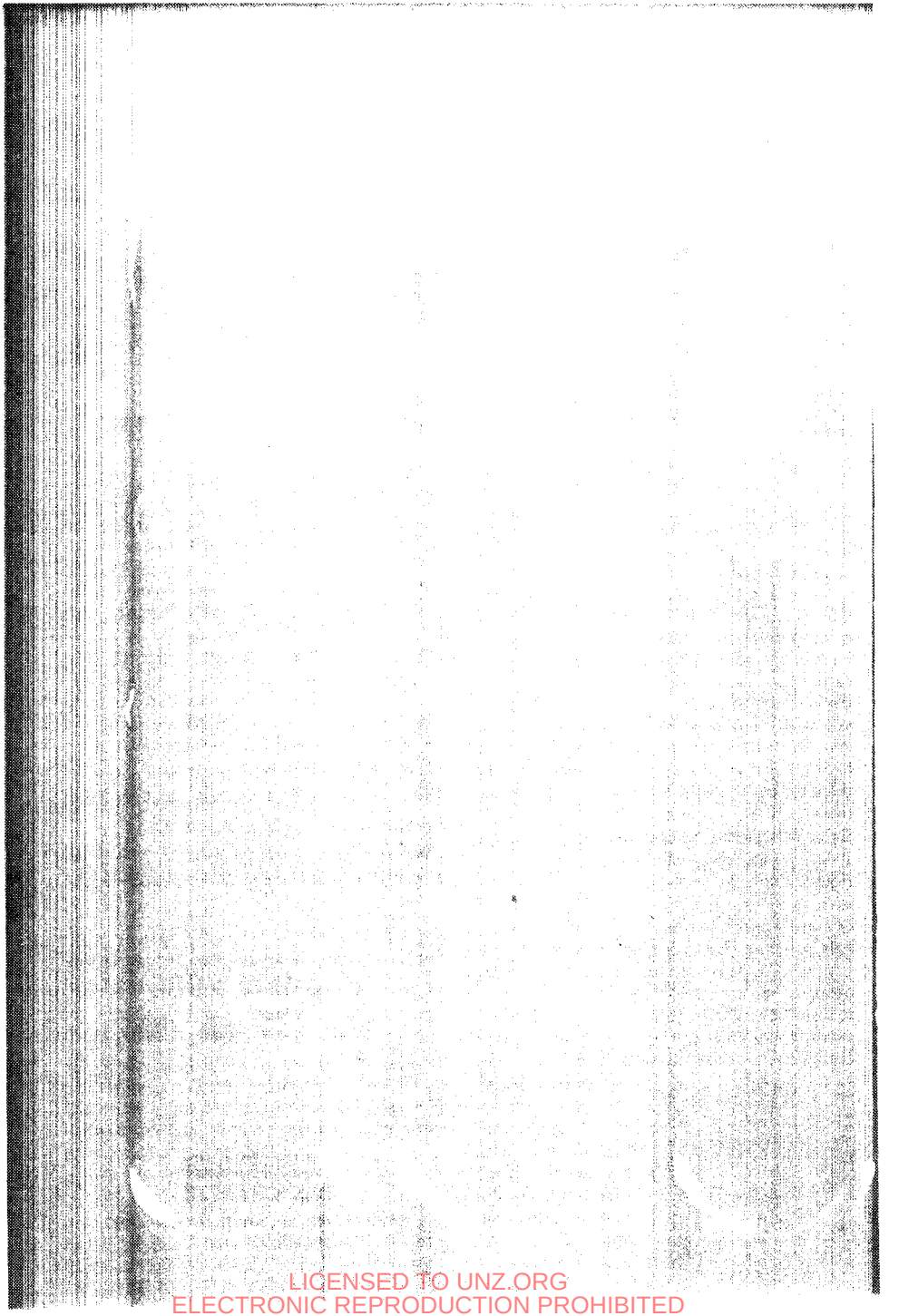
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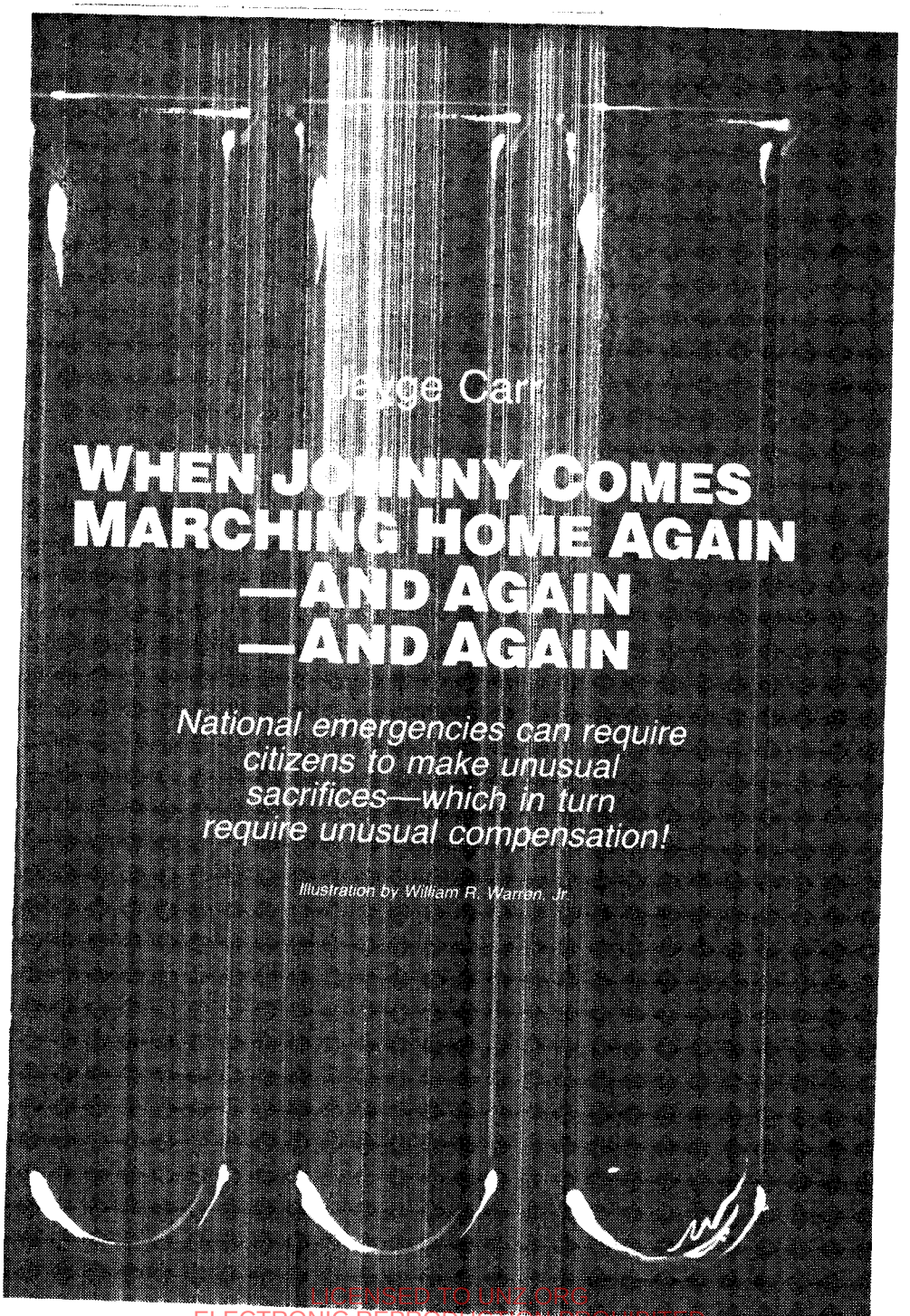

Jerge Carr

WHEN JOHNNY COMES MARCHING HOME AGAIN —AND AGAIN —AND AGAIN

National emergencies can require citizens to make unusual sacrifices—which in turn require unusual compensation!

Illustration by William R. Warren, Jr.

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His name wasn't Johnny, it was Ambrose, and he was a *bona fide* war hero, in his own way. And he didn't come marching home, he ran, because it had been a hard year, and a long time, and his wife—

Took one look at him, screamed, and slammed the door in his face so hard it made his cheek sting. Ambrose jammed his ident into the commplate, and the door irised open again. His wife was standing there, mouth open in mid-scream. When she saw him again, she keeled over in a dead faint.

He stared down at her, more furious than anything else. Then he stalked over to the autobar, dialed for a liter of ice water, and dumped it over her recumbent figure.

"Is this any way to greet a returning hero?" he snarled. "I'm home, I've all my arms and legs, the scars can be taken care of by cosmesurgery if they're that offensive—"

But she merely moaned, and then scrambled around his legs to the comm. Dragging herself upright, and ignoring the angry man stomping up behind her, she punched a code, and spoke. "Darling, get home, quick, there's a madman here!"

"A madman, am I! I'm your husband and don't you forget it. Who's darling? If you wanted a war divorce why didn't you file? What's going on here?" He grabbed her shoulder in a way he'd never done in his life before and shook. "What's going on here?"

Tears spurted out of her eyes. But when he, with an effort of will, took his hands off her shoulders, she said, "Who—are—you?"

* * *

Same song, second verse.

He'd lost a leg in the war, and decided, very sensibly, to wait for the month plus it would take to have a new leg clonegrown and grafted on, in place of the emergency issue prosthesis. (Ugly things, prostheses!) All at gov expense of course. Why not, nothing too good for the returning hero, eh?

But when the hero returned—not so much of a delay, because he was fairly close to his home system—he found his ident wouldn't work the apartment door. He frowned. If Marie had been planning to move, she should have written him.

He pushed the console-engage square then, and the impersonal voice of the family computer chimed in the hallway. "Yes, who is this?"

"I need the new address of the previous tenant," he said, thinking she had moved and the notification had somehow missed him

"I'm sorry," droned the impersonal autovoice, "that information is classified. The previous tenant has requested unlisting."

"No!" He flinched back. "But I—I'm the previous tenant. That is, I mean, I'm one of the two previous tenants. I left my wife here, while I went off to serve. You can't deny me my own address. I'm sure somebody should have notified me, only I was serving in a secr—I mean, isolated base, and—"

"I'm sorry," droned the autovoice. "If you can't identify yourself, I can't—"

"Blast it all, I did identify myself."

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"I'm sorry, that code is invalid."

"Of course it's invalid, you idiot machine, if Marie's moved. I'm asking you to tell me where it's valid," he howled.

He could have sworn the machine snickered, except that machines couldn't snicker. "That code is invalid," it repeated.

"Piece of advice, buster." It was a strange woman, long and wiry, about to insert her card in the next door.

"Yeah!" He whirled, furious and embarrassed.

"Next time you try to counterfeit a code, at least use a current code." She smiled, gave him an up and down look that was as explicit as an engraved invitation.

"It's not counterfeit, and it's current," he snarled between clenched teeth.

She chortled. "Sure it is, buster." She gave him another look, smiling slowly. "Did you just intend a spot of rip-off, or were you after something a little more—personal."

"I want my wife!"

"Real-ly?" Her cobalt-blue eyebrows, sequined, went up. "Well, you have made a mistake then. Her hubby got back from the war a couple of months ago, and apt rumor says there was never such a pair of honeymooners—young love," she sighed ecstatically, with an undertone of cynicism.

"Oh." Marie had moved, then. She was a little younger than him, and though either of them could give this woman twenty years or so, he wouldn't have called Marie young. They weren't teens, either. "Look, maybe you can help me. My wife must have moved, if you could tell me where the previous tenant moved to?"

She gave him another up and down look. "If you say so, buster."

Frustrated, he slammed a fist against the door, too angry to even feel the dull ache that resulted.

She frowned. "I halfway think you're telling the truth."

He slammed the same fist against the wall. "I don't care."

"You should. Because if you don't get back in the lift soon, the building security will be hauling you down to a cozy soundproofed room and asking you some very direct questions in an unpleasant manner."

He simply stared at her, face blank.

"There's been a war on, buster," she said crisply, "and even now we don't take chances with spies."

"Spies." He snorted, thinking of the medals they'd promised him, no doubt buried somewhere in the bowels of bureaucracy.

"You know, it's that ignorance of yours that makes me think you may be telling the truth. Been away long?"

"Too long." He sighed, and leaned his head again the cool unyielding wall.

"I do believe you, come on in." Her own door opened, and she beckoned.

"Wha—" It had been too much, after the long wait, the happy anticipation, locked out of his own home like some nameless beggar.

"Come in," she repeated sharply, grabbing his arm and tugging. "Unless you want security to work you over." He hardly knew what was happening, except that somehow he was stand-

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ing in a room that resembled his own in no way but size. "Wow!" He blinked and turned his eyes away from blazing colors whose abstract shapes tugged at his mind.

"Relax," she said. "You won't have but an hour or so to wait. I don't know them personally. Well, him I haven't seen, and her just enough to recognize once in a while in the lift and speak to, but either the wife or the hubby should be back from work sometime this evening. You stay here, and then ask either of them what happened to your wife. They're bound to have her new address. Just a little more delay." She smiled again, mixed a drink with practiced ease, and handed it to him.

"Well, yeah, thanks, didn't think of that," he mumbled. "Just a little delay." He drank, without knowing what he drank, hardly feeling the burning as it etched its way down.

"Sure." She topped his drink off and sipped her own. "Just a little delay."

Again he drank, and then, eyes adjusting to the assault, looked around. "You sure decorated this place—ahh—boldly."

She smiled a secret smile. "I always felt your own place should reflect your personality."

"Yeah, sure." He drank again, absentmindedly, then, remembering manners drummed in at an early age. "Say, I didn't thank you, did I? I really appreciate this, y'know. I—I thank you. I wish there were some way to pay you back, for your kindness, I mean."

She topped his drink off again and smiled. "Oh," she murmured, "I'm sure you'll find a way."

It was several hours later when, brain fuzzy, he found himself in front of a door. Almost as if a voice in his head—or a memory—had told him what to do. He pressed the visitor announcer instead of trying to insert his own card.

"Yeah," said a husky male voice.

"Uhh." Again it was almost rote. "My name is Goddard. I'm married to the woman who used to live here. I had hoped you could tell me where she moved to, I'm sure the notification went wrong, and I—"

The door irised open.

Ambrose had just long enough to stare at the man framed in it in total disbelief when the fist came up and put him out completely.

Same song, third verse.

He had been very far away, in an isolated station, and it took him several months, once the war was over and his station disbanded, to make his way back home.

By then they had learned their lesson.

They picked him up at customs, asked him to come inside for a debriefing, and that was all it took. He wasn't hurt, food (rations, he grimaced, when he had promised himself good home-cooked meals!) arrived regularly, but he was all alone in his monastic cell. He had a 3-V and games screen at his disposal, but nobody came and nobody talked to him. For three interminable weeks.

They came to get him finally, a squad of six guards and a tall, thin

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man whose weak face and soft body made him an obvious civvie, a button pusher.

"About time," he snarled. "What the piss is all this about?"

"Quarantine," the button pusher soothed. "I muchly regret, it's just routine."

"Quarantine?" he howled. "But I was never exposed to—"

"If you'll just come with me, sir." The button pusher took his arm in a companionable way that said he, at least, had no fear of contagion.

He didn't realize that an autoinject had been skillfully inserted, only that his anger was suddenly gone. "You'd better have a good explanation," he muttered. "Do you realize how long it's been since I've as much as seen my wife?"

"Yes, we do." The button pusher urged him on with gentle inexorability. "And we wouldn't have done this if it hadn't been an utter necessity."

"Quarantine," he snorted.

He walked into a large room and stopped, as if somebody had smashed him in the face. The button pusher and the guards had gone back to join a line circling the large room. But it wasn't the anonymous ciphers about the perimeter that hit him in the face. It was the fourteen men who had turned around to stare at him when he walked through the door.

Fourteen men who all wore his face.

Ambrose, who'd done a stint as an admiral's aide, and learned about politicking the hard way, looked up as still another poor dupe was escorted in with no warning. He watched the sucker's jaw drop as his gaze went from one identical face to the next.

They weren't all exactly alike, of course. Some had been wounded, and the clean-up surgery was never quite the same. Some still had their scars, even missing a limb or eye.

But over all, it was if someone had put in reflecting mirrors. Different clothes, though most had uniforms on. But fifteen identical shocks of nutmeg-brown hair, fifteen identical cowlicks, fifteen off-sided mouths that could twist into fifteen identical boyish-cynical grins, fifteen—

Ambrose shrugged to himself. *He* was the original, the rest were just poor duplicates—dupes in more than one sense of the word!—and when they got this nonsense straightened out—

Ambrose felt sorry for the latest one in. At least earlier arrivals had had time to get over the shock. When they'd explained it to him, weeks ago, he'd assumed it would be some sort of android with his skills and talents. Not that he'd be seeing exact human-looking duplicates of himself walking around. Even the voices sounded the same, except for the dupe two down from him, who had been wounded in the throat, and now sounded husky. He wondered idly what they intended to do with the rest of them. Of course, as he was the original, he would be able to slip back into his old life, the good job—and Marie—

Ambrose scratched the itch where the join was between his body and the cloned replacement leg. What a

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mess! If he'd just come straight here, it would have been all settled. After all, he was the original, and the rest were just poor dupes. Funny. He'd never visualized them as looking like real people, more like the mechs that did the dog work in production lines and control centers and the like. But there—they even smelled like real people, sweat and musk and remains of soap/cologne/whatever. He frowned. Well, maybe if they had plastic surgery, so they didn't look so much like him . . . sure. Give them plastic surgery, find jobs for the poor geebs, heck maybe a gal who didn't know they were just artificial dupes might even be willing to—

Ambrose watched his fourteen dupes through narrowed eyes. Fourteen. Well, if the gov wouldn't take care of them—he would. He hadn't busted out of that POW camp and kept himself alive all through the war without knowing how. Fourteen of them. It might take a while. But it was like it had been then, it wasn't murder. He was the original; the rest should have been shut off as soon as the war had been over and they hadn't needed—

Three more identicals had been added before the door at the back of the room opened and a short, gray-haired man advanced to a slight dais and stood behind a rostrum, tapping on it lightly for attention.

"Doctor Rivers," came an eighteen-fold chorus.

"Dear me." He pulled off the old-fashioned link-to-sockets sit-on-forehead viewer, shook the plugs hastily to get off any dust, and inserted them back into their sockets, to stare bemusedly at his audience. "Dear me!"

"Dr. Rivers, don't you recognize me, I'm—" Ambrose with the scarred face had risen almost without thinking about it, but he stopped when he realized his voice was part of an unsynchronized chorus. He stopped, glared around him. "Will you bloody copies—" He started to say—

In the row in front of him, two Ambrose dupes had leaped on each other and were rolling on the floor, cursing and gouging. Next to him a dupe had turned to glare. "What did you call me!"

"Copy!" Ambrose snapped, patience gone.

"You're the—" The other Ambrose slammed back a hand, and nearly took Ambrose's cheek off with the violence of his swing.

Ambrose, the ex-guerrilla, decided this would do as well as any place to start the campaign. Under the cover of the riot, he neatly broke a neck, and then—four hands clamped down on him, and a guard was bellowing for a medic. Medics whisked the Ambrose whose neck had been broken away, but it was several minutes before the rumpus was calmed down and the rest of the Ambroses were sitting again, several of them sporting black eyes or blood or bruises.

"Gentlemen, please." Dr. Rivers jiggled his viewer nervously. "I've had to bring you here together today—"

One of the Ambroses stood up. "Your bloody watchdogs hauled me

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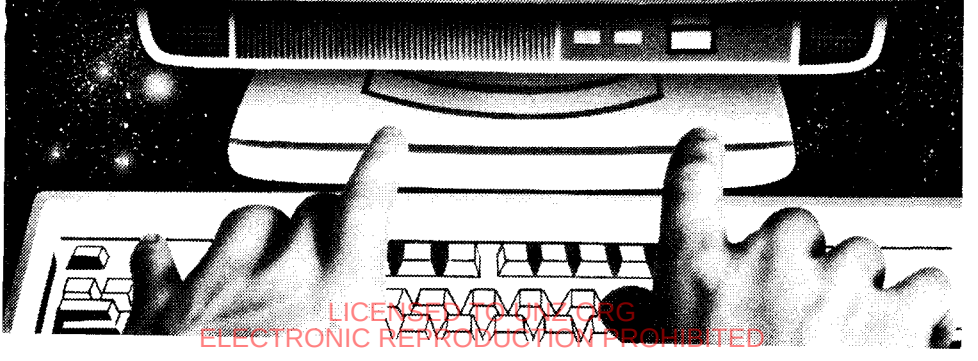

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away from my wife and I—"

"What! Marie!" tore out of a dozen throats.

"*My* wife." He faced them all. "And you dupes better—"

It took even longer to calm them down the second time, and when they were quiet, each Ambrose had a guard standing behind him with a peacegun, ready to blank him out if he as much as looked cross-eyed.

"Oh dear, oh dear!" Dr. Rivers stroked his narrow chin goatee with a nervous habit long familiar to Ambrose. "Oh dear." He appealed to someone standing against the back wall. "I really don't know how to say this."

"Quick and clean," came a voice from the background. Ambrose thought it sounded like the bureaucrat who'd escorted him here, but they all sounded alike, anyway.

"All right." Dr. Rivers straightened narrow shoulders. "Gentlemen, I regret to inform you, but your original died at his post, some two years after the war started."

Ambrose jumped as if someone goosed him with a live wire, and then relaxed. Some mistake. *He* was the original. He knew he was. Then he had a horrible thought. And looked around. Sixteen other pairs of identical eyes were looking around. Ambrose didn't need to be a mind reader to know what was wrong. They all thought they were the original, too! But how was he to prove—

Six of the Ambroses stood up and started arguing, despite their guards.

"Gentlemen." Dr. Rivers was firm. "There has been no mistake. Believe me, we've checked. Your original died, over two years ago."

"But—" Ambrose said, sitting down. Thumps, as other Ambroses sat.

"Each of you feels you are the original, because you have the original's memories, duplicated just as the body was. But the fact is that you are all duplicates." He paused, saw seventeen pairs of eyes staring at him in patent unbelief.

"Now." He took a breath. "We've decided that the only fair thing is to pay each of you the funds awaiting you as a result of your war efforts. Or indemnities." He knew that three of the Ambroses had been captured, though he didn't know which three they were.

"We will pay each of you the maximum that any of you has earned. But surely you can see that you can't all stay here. We have made arrangements. We will arrange to ship you out, each to a different planet, as soon as the space on enough different ships becomes available. Once you've arrived on your new worlds, a job similar to the one you had will be found for you. We have also decided to add the amount that you had saved before the war, so no one will be financially burdened."

Eight of the Ambroses shouted in a ragged chorus. "Fine. Money and a job. But what about my wife?"

"We have done considerable thinking about that." Dr. Rivers spread his hands pleadingly. "There is only one fair way to do this. Each of you, as you leave, will choose a numbered disc from a jar that one of my assis-

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tants is holding. After all are chosen, and you are gone, we will computer generate a number between one and eighteen." He shrugged. "Naturally, her memory of the last three months, when the first one of you arrived, thinking he was the original, will have to be wiped out. For her husband, it will be as if he had just returned—"

"What about the rest of us?" growled from several throats.

Dr. Rivers bowed his head.

Ambrose stood up. "If I don't agree to a one in eighteen chance?" he said softly. And realized once again, at least half of his fellows had done the same thing.

"I'm sorry." Dr. River's gaze went from one man to another. "You have no choice. You will be held as you have been, incognito, until arrangements can be made—"

Ambrose who had kept himself alive as a guerrilla spoke softly. "That's not good enough."

"I want my wife!" came a chorus.

"You did this to us." This Ambrose rubbed at the join of his cloned leg. "You're responsible."

Dr. Rivers spread out his hands. "What more can we do?" he asked softly.

Silence.

"One chance in eighteen is better than none," he said persuasively.

Fourteen Ambroses spat. The others growled under their breaths.

Ambrose, who had had to learn about politicking the hard way, asked suddenly: "How many of us did you clone?"

"Fifty." Dr. Rivers was surprised into the truth.

"No. Not how many of *me* did you clone. How many different victims have you made duplicates of? How many other guys are fighting over their lives?"

Dr. Rivers sighed. "Most clones were somebody with very special talents or training, and we made only a few. Most were in very strategic positions, and the war took care of the problem. In some cases, we have duplicates who were satisfied with the money and job. They weren't married, or didn't care. But as you all know, you were a newlywed. It was your *idiot savant* talent with mathematics that made you invaluable as a back-up—"

"I know that," Ambrose the politicker said impatiently. "What you're saying is, you managed to cover up the mess in everybody else's case."

Dr. Rivers swiped at his forehead under the heavy viewer camera. "It wasn't that simple, but essentially, yes."

Firmly. "For us, you're going to have to come up with something better. Right, guys? Or else."

Dr. Rivers blinked. "Or else what?"

"A different or else for each of us," grinned another Ambrose, rubbing at his facial scars. "That's what makes it interesting. Or, shall I say, that's what will be your goad . . . I mean, goal."

All the Ambroses were nodding, grimly.

Yet another Ambrose, husky voiced from a throat wound, summed it up. "Do better. Or else." They had all been soldiers. They all were nodding. The guerrilla was fingering

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where the knife they had taken away from him usually hung. Several Ambroses were smiling grimly. Several Ambroses had a light in their eyes that promised Dr. Rivers, and his cohorts, trouble and heaps of it.

"And do it fast," said another Ambrose. "Longer you wait, harder to keep all quiet, right."

"You're smart. You made us, after all. You can come up with something." This Ambrose had spent the war comparatively easily. But he was thinking about skinning someone, very, very slowly. And it showed.

"Do better," another Ambrose advised, in a genial tone that fooled no one.

So they did.

Ambrose and Marie were boarding a shuttle to Luck's Lost. "They told me you were dead, early on," she was saying. "It's so wonderful to have you back, I can't believe my good fortune. . . ."

Ambrose and Marie were second honeymooning on Playboy's Moon. "Isn't it better to have the happy surprise of my being alive after all, then to have been told I was alive and have me turn up dead. . . ." he was saying.

Ambrose was explaining about his leg while they were packing the all new clothes needed for their move to Cinnamon System. "Except for a little scar at the join, it's just like it used to be, and—"

Ambrose and Marie had gone to Chanel City, most fashionable on the whole planet, to pick out a whole new wardrobe for their emigration to Canbera Two.

Ambrose and Marie were looking through a choice of worlds of immigration. She was very excited about not only having her husband back, alive when he should have been dead, but emigrating to a whole new world.

Ambrose and Marie . . .

And Marie . . .

And Marie . . .

Eighteen Ambroses. Eighteen Maries. Progress can solve the problems progress causes . . . sometimes. ■

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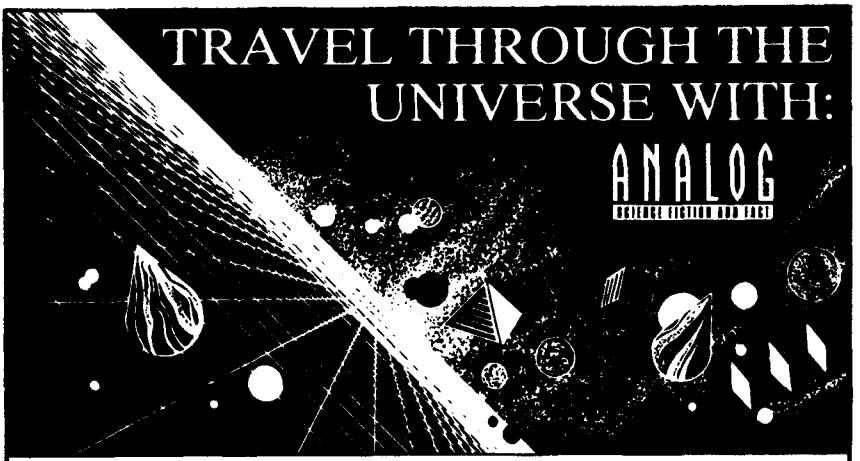

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Mark S. Lesney

OLD MACDONALD HAD A PHARM: GENE FARMING AND THE BIOPHARMACEUTICAL REVOLUTION

Since the dawn of agriculture, farmers have been breeding plants and animals for human needs, primarily food and fiber. Science fiction scenarios of future farming have generally concentrated on asteroid or space station hydroponics, undersea gardens or terraforming on a massive scale. But with the coming of molecular genetics, new and wilder possibilities have been emerging, not only in the pages of science fiction but in the reality of the modern research lab.

Vast efforts are being placed in the area of genetic engineering for the purposes of improving plant yield and nutrition. In combination with traditional plant and animal husbandry these may yield the transgenic crops that ultimately may supplant the "natural" varieties upon which agriculture, and hence your neighborhood supermarket, currently depend. The slow-rotting tomato approved for market in spring 1992 was the first of these new products. Disease, insect, and herbicide resistant crops are sure to follow, as well as crops with flavors genetically designed in the lab.

But this article focuses on the more novel and totally nontraditional use of the new technology: using molecular tools to transform the creatures of the farm into the living factories of the "pharm."

Currently most of the glamour of the genetic engineering revolution in medicine is focused on human gene therapy: the molecular insertion of functional genes into people with genetic diseases. Yet the most profound effect of gene splicing on human health and welfare will most likely come in more mundane, yet no less technologically spectacular ways. It will involve the use of genetically engineered animals and plants to produce commercial scale levels of human proteins, hormones, and gene products in a microcosmic fusion of beast and man. Many future farmers

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will instead be future pharmacists, grazing the living factories of biological drugs on grassy meadows, or planting them in neat-rowed fields.

This is not some distant future, but has already begun, with private companies and universities scrambling towards the market place.

OF MOUSE AND MAN

It was only in 1985 that the first genetically transformed animal was reported in the scientific literature. The beastie was the Harvard supermouse, which contained and expressed the growth hormone gene normally found in rats. Hormones are proteins synthesized in the cells of animals that influence various aspects of growth and/or metabolism. As might be expected, in a miniature parody of H.G. Wells's "Food of the Gods," mice the size of rats were produced. In agricultural terms we might imagine a dairy cow the size of a slightly less than full-grown elephant.

In 1988 mice again moved boldly forward to make the first human proteins in a genetically engineered animal. Perhaps it was significant that a current and former scourge of agriculture was now turned to human need, and, in a small sense, transformed to human flesh. Her tiny teats yielded, not the milk of human kindness, but rather the milk of human t-PA, a protein currently in use as an anti-clotting drug for heart attack patients.

More recently Nancy, the transmutant Scottish sheep who produces the human alpha-1-antitrypsin protein (AAT) in her milk, gave birth to a healthy daughter, Nancy-2, who also carries the human gene. AAT deficiency in humans effects some 100,000 people in Europe and North America alone with tissue degradation leading to lung problems and emphysema.

Meanwhile, in the US, cows are being developed to produce human lactoferrin, a milk protein, and in Canada human beta-interferon (an anti-viral, anti-cancer compound) has been introduced. There are pigs that make human hemoglobin, the oxygen-carrying protein in blood; and goats that produce a more abundant yield of the protein t-PA. In France, rabbits are being transformed to produce the protein factor 7 and human erythropoietin. Already we have mice that produce human growth hormone in their milk, prelude to the eventual use of sheep, goats, or cows. In short, the new Animal "Pharm," with all respects to George Orwell, will produce humanlike animals that serve, not as satirical expounders of human philosophy, but as the source of human proteins and as the foundation of the new medical laboratory and pharmacy of the future.

Not to be outdone, the traditional agricultural crops look forward to an equally transformed future. Human genes have been fused to plant chromosomes to develop future crops that will yield bio-pharmaceuticals in quantities previously undreamed of. Tobacco and potatoes have now been produced that yield human serum albumin, another important blood protein. Oilseed rape and *Arabidopsis*, the tiny weed that is the current labo-

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ratory model system for plant genetics, have been developed that produce the human neurotransmitter Leu enkephalin (important in brain and nerve functions) as a storage protein encapsulated in their seeds. Tobacco and alfalfa have been developed that produce human antibodies: the disease-fighting molecules in human blood. And in plant cell culture (the prelude to the whole plant stage) human insulin has lately been produced.

It's obvious why we would become excited at the thought of the medical potential of brand new bacterial antibiotics, cancer-curing plant compounds from the rainforests, and strange neurotoxins from sea invertebrates. But why the excitement at producing proteins in plants and animals that any healthy human makes in sufficient abundance to normally maintain her own health?

First, many people do not produce the "normal" amount of typical human proteins and this accounts for various abnormalities and genetic diseases from dwarfism to diabetes to cystic fibrosis. Second, sometimes the "normal" amount of proteins is not enough. In various cancers, coronary heart diseases, and even many infectious diseases, sometimes the body is just not capable of fighting back hard enough. An increased flush of disease and stress-fighting proteins might make the difference between life and death. And there is even some evidence that increasing human growth hormones in healthy, but elderly, patients can be important in anti-aging efforts, the first attack on some of the "inevitable" declines of the aging process. But this is all the tip of the iceberg. Until the recent dawn of molecular biology it has been impossible to even conceive of testing many of these human compounds for their health and metabolic effects. They are just produced in too low an amount in the average human for purification of sufficient amounts from blood or urine, or from cadavers, and routine use has been impractical. But that is changing due to the new biology.

So how do we get these proteins produced in the massive amounts needed for practical medical purposes?

Anyone familiar with the genetic engineering revolution knows that most of the work has been done using micro-organisms and isolated cell cultures, not full-blown animals and plants. Genes have been taken from human beings and inserted into the bacterial genetic engineering workhorse known as *Escherichia coli* (*E. coli* for short). Human proteins from microbial sources have been purified and are now used routinely for medicinal purposes. For most things this has been and will be the easiest, most economical, and (from the point of view of animal usage) the most ethical approach.

But there is a significant difference between bacteria and man compared to man and sheep (or even man and tobacco). And this is the rationale behind the whole concept of "pharming."

Bacteria are prokaryotes. In simple terms this means that they have very

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primitive genetics and very primitive biochemical abilities compared to higher level organisms, called eukaryotes, which include human beings, other animals, plants, and fungi.

Many human proteins are highly complex. They are processed in ways that bacteria cannot accomplish. Stick a gene for one of these enzymes into *E. coli* and you get a protein that, though accurate to a degree, is dysfunctionally incomplete. If an enzyme can be thought of as a metabolic tool, then bacteria can be thought of as sometimes making a hammer without a handle, or an electric saw without a plug. Eukaryotic cells have the ability to add that handle or attach the proper wires for the plug. In real biochemical terms, the handles and the wires are chains of various sugar or fat molecules. So where *E. Coli* might make a protein useless for medicinal purposes, the sheepish version would be as accurate and useful as that made in a man.

Now some scientists are developing extraordinary approaches to process the incomplete bacterial product in the test tube to the appropriate final protein, sugars or fats and all. But this works easily only in some cases and will require substantial research to make it feasible in all instances, if ever. The cheapest and easiest current approach does, in many cases, seem to be the use of higher plants and animals.

How do we make an animal or plant into a mini-version of the human biochemical factory to raise on our future pharm?

The figure entitled "Animal Pharming," shows the method most commonly used for animals. Although we usually think of chickens when we think of eggs, all animals, including sheep and mice and men, come initially from eggs that, when fertilized, grow into embryos then fetuses then babies.

To transform these fertilized eggs, the human gene (the DNA blueprint for the medicinal protein of interest) is purified from human tissue. It is then cloned into a bacterium, not for protein production but to produce many hundreds of copies of the gene that can then be isolated in a stable and reproducible manner. Many copies of the gene are then injected, with a very fine glass needle viewed under a high-powered microscope, into these living eggs. These eggs are then re-implanted into an animal mother for normal development. The baby animal that is born, if the scientists are skillful enough and lucky enough, has absorbed the human gene into its own genetic makeup in a stable form. It then produces the human protein in the appropriate tissues or at the appropriate time. As has been recently demonstrated, these animals can pass on the added human gene to their children.

Plants are transformed in a similar way but usually using a specific bacterium (called *Agrobacterium*) as a "living needle" to carry the gene of interest into the plant cell, which is then regenerated into an entire new plant which contains the foreign gene. Or the DNA is coated onto microparticles and fired into living plant cells with a particle gun using an ex-

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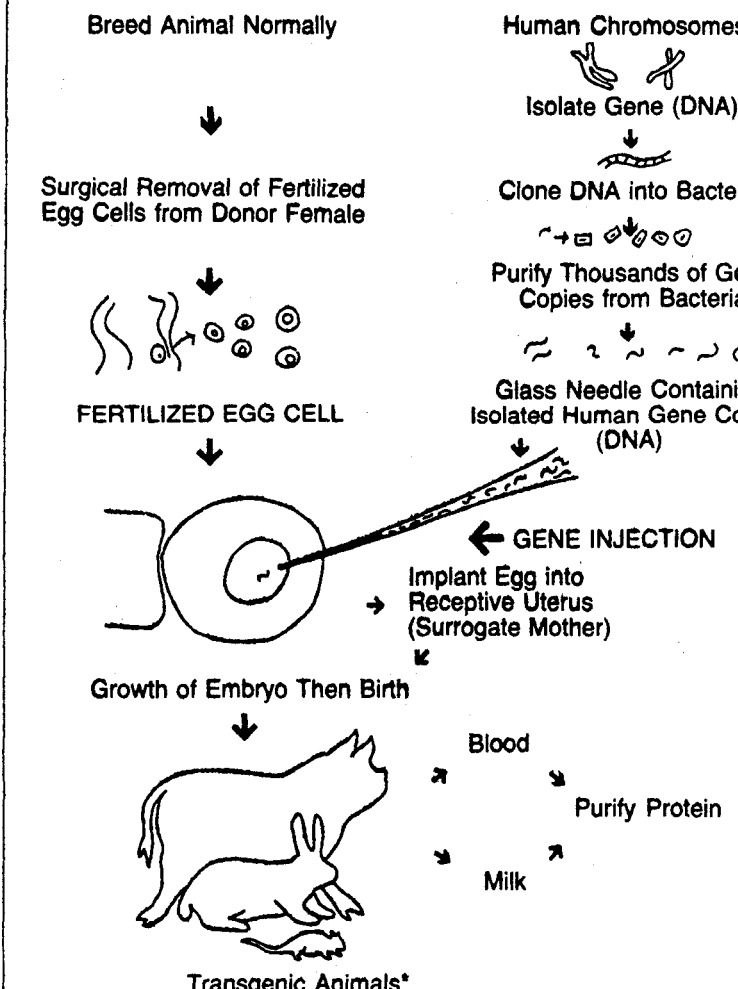
Animal Pharming



*Once they contain the human gene the animals can be bred until a stable inbreeding flock or herd is developed for indefinite pharmaceutical production on the "pharm."

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plosive charge to accomplish transformation. As with animals, the protein of interest is produced at the appropriate time and tissue.

How are these times or tissues determined? As mentioned above, the ideal for an animal is to have the protein product produced in either the female's milk or in the animal's blood. It's easy to milk cows or sheep (a little harder for mice but the principle is the same). On a more macabre note, it's also fairly easy to harvest and purify blood. In plants, on the other hand, there are numerous options, including leaves, roots, stems, and fruit: given the ideal storage nature of plant seeds, this is often the most desirable site for protein accumulation. Farmers, of course, know how to collect seeds as part of normal agriculture practice, so this is an ideal situation. How the genetic engineers accomplish this protein production on location, and on demand, is based on how normal plants and animals control their own gene products and is one of the most exciting discoveries of modern molecular genetics.

To simplify things, you can think of most genes as sequences of DNA on the chromosomes in the nucleus (the cell brain) that ultimately act as the blueprint for proteins. These proteins are manufactured by the cell only when a copy of the blueprint (called RNA) is passed from the nucleus to the rest of the cell (cytoplasm) where the biochemical engineers (enzymes and ribosomes) follow the directions. If the blueprint copy isn't made, neither is the protein.

It turns out that many, if not most, genes have on/off switches for copying the blueprint. These switches are called promoters.

The figure entitled "Gene Regulation" shows how different promoters can be thought of as being like the different-shaped holes in the hole and peg puzzles used by psychologists and children. We can imagine a "square" promoter requiring a square-shaped compound or "peg" to fit into it and turn it on, a triangular peg for a "triangular-holed" promoter. Other combinations just don't fit. The pegs can be thought of as activating biochemicals produced by the animal or plant at specific times or in specific tissue locations. These pegs are either protein or a specialized form of RNA. For example, there are some "peg" proteins that turn on specific gene promoters which are produced only in female mammary glands during milk production, other "peg" proteins or RNAs are only produced in plant seeds.

As the figure shows, in order to program a particular gene to be turned on in either milk gland or seed cell, all that is necessary is to attach the appropriate promoter to the gene in question and incorporate it into the plant or animal nucleus. In the right cell type, the desired activator is naturally produced and the gene turns on. In each "mismatched" promoter/cell combination, the gene will remain off, i.e., the mammary gland cell will be unable to turn on the gene that has the "square-holed" plant seed promoter attached but will be able to turn on the matching promoter that fits (triangle to triangular

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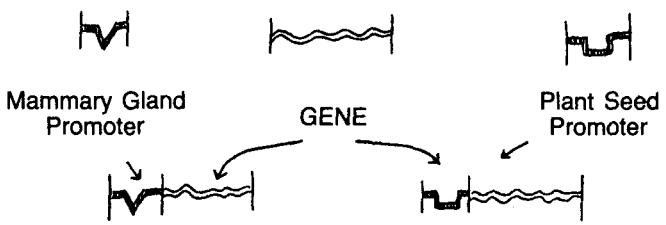
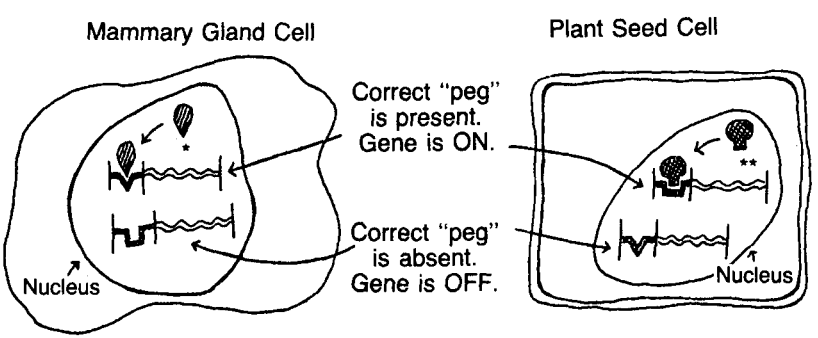
Gene Regulation

(1) Isolate Gene (DNA) and Attach Promoter (DNA)



(2) Insert gene plus promoter into a plant or animal using genetic engineering.



Gene expression is controlled by presence or absence of the specific activator "pegs." When the gene is turned ON by the correct activator, the RNA blueprint copies can be made and used to construct the appropriate gene product in either milk or seeds.

*Mammary Gland cell specific activator protein or RNA.
**Plant Seed cell specific activator protein or RNA.

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"hole") its own activator protein "peg."

This is critically important. The presence of an alien protein at the wrong time or place can disrupt normal cell behavior as trivially as a Brahms lullaby on the harp played during a heavy metal performance, or as drastically as dueling electric guitars at full amp during a requiem mass. In plants this could produce low protein yields, unexpected toxins, or twisted growth. In animals it could produce low yields, suffering, deformity or even death, all of which lead to ethical questions of animal rights and human responsibility, not to mention economic waste. The use of the proper promoter alleviates the majority of these risks by ensuring that the protein is turned on only when and where it is wanted. This is easiest by ensuring that the gene is only promoted in the milk glands, safely separate from other tissues in animals; or in the case of plants by using seeds (which are a separate tissue from the mother plant and well designed to store proteins as part of evolution). This allows systems to be developed and tested where yield and purity of the final protein product

TABLE 1

Some animal species into which human proteins have been cloned for potential pharmaceutical production. Clinical use refers to current or potential utility of the protein in human medicine.

Species	Human Protein	Proposed Clinical Use	Ref#
Sheep	Factors VII & IX	Anti-Hemophilia	1
	Alpha-1-Antitrypsin	Anti-AAT Deficiency	4
Pigs	Growth Hormone	Anti-Dwarfism, anti-aging studies	1
	Hemoglobin	Blood substitute	2
Cattle	Lactoferrin	Milk substitutes	4
	Beta-interferon	Anti-virus/cancer	7
Goats	t-PA	Anti-blood clotting	4
Rabbits	Factor VII	Anti-Hemophilia	4
	Erythropoietin	Anti-anemia	4
Mouse	Transmembrane regulator	Anti-Cystic Fibrosis	6
	t-PA	Anti-blood clotting	3
Hamsters	Erythropoietin*	Anti-anemia	5

#Refers to the number of the reference article where more information can be found.

*Compound currently produced in laboratory cell culture, not in the whole animal. Has been approved in Japan for use under the brand name Espo.

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are the primary issue and not the health or survival of the living factory that produces it.

Table 1 and Table 2 give a summary list of some of the human proteins placed in the genetic blueprints of some common animals and plants that may one day be in mass production on future pharms.

Sheep are very tractable animals and have so far been one of the most successful subjects for transgenic use. Sheep eggs have been transformed with several human genes that have been linked to the mammary gland promoter so that the proteins will be expressed in milk.

Nancy, the transmutant Scottish sheep who produces the human protein alpha-1-antitrypsin protein (AAT) in her milk, gave birth to a healthy daughter, Nancy-2, who also carries the human gene. This, coupled to earlier work in Canada which produced a human beta-interferon transformed calf from a transgenic cow, provides the ultimate demonstration that this technology can be adapted to one of the oldest of genetic engineering techniques, the one that we call sex.

AAT deficiency affects some 100,000 people in Europe and North America alone with tissue degradation that can lead to lung problems and emphysema. A supplemental spray of AAT into the lungs can alleviate the problem. So medically, and as

TABLE 2

Some plant species into which human proteins have been cloned for potential pharmaceutical production. Clinical use refers to current or potential utility of the protein in human medicine.

Species	Human Protein	Proposed Clinical Use	Ref#
Alfalfa	Antibodies	Antiserum, Diagnostics	13
Tobacco	Serum albumin	Blood Protein	13
	Antibodies	Antiserum, Diagnostics	13
Potatoes	Serum albumin	Blood Protein	14
Oilseed rape	Leu enkephalin	Natural Opiate	12
Arabidopsis	Leu enkephalin	Natural Opiate	12
Yeast*	Factor XIIa	Anti-Blood Clotting	8
	Leukocyte Inhibitor	Anti-Emphysema	9

#Refers to the number of the reference article where more information can be found.

*Actually a fungus, but authentically a eukaryote more similar to plants than animals.

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a model system, AAT producing sheep are an excellent example of the economic potential of the new technology. The projected worldwide market for AAT is more than $100 million yearly. Nancy's milk alone is currently valued at $150,000 a year. Most importantly, a single flock of Nancy's descendants might be able to fulfill the world's requirements for AAT.

In Homer's *Odyssey*, Odysseus's men were turned into swine by the enchantress Circe. Today, in a modest reversal, pigs are being (in a very small sense and with all apologies to Miss Piggy) turned into men by the incorporation of several human genes into their genetic makeup.

Initial efforts were to express human growth hormone (HGH) in pigs, and this was successful, despite the fact that the presence of the foreign protein in their blood did not make them grow faster, although it did increase the leanness of their meat. In fact, the presence of the hormone was actually deleterious and many of the pigs developed arthritis. Since HGH can be produced both in microbes and in mouse or sheep milk without such consequences, this is likely to be a dead end in "pharming" except as a model system for scientific study.

The most important current role envisioned for pigs in the "pharm" scenario is that of providing blood substitutes for man. Hemoglobin carries the oxygen that every one of our cells needs to survive, ferrying it from the lungs to every corner of the body in our blood stream. Normally, hemoglobin is found in our red blood cells (it is the colored molecule that makes these blood cells red). The idea of cell-free blood substitute systems is based on the fact that free hemoglobin can carry oxygen and release it to some extent just as easily as if it were within a normal blood cell. Whole human blood is highly perishable, often in short supply, and must be "typed," that is, properly matched between donor and recipient, to prevent a potentially fatal allergic reaction. Free-floating human hemoglobin solution blood substitutes have almost none of these difficulties. In addition, one of the deadliest risks of many operations and many diseases is that of blood clotting. Whole blood transfusions can compound the problem, because it is the blood cells themselves that form the clot. Blood substitutes, because they are cell-free, are envisioned as an ideal compromise between oxygen transport efficiency and clotting risk in many of these cases.

Because purity and uniformity are so critically important in any medicinal application, relatively easy and highly efficient methods have been implemented for the purification of drug quality human hemoglobin free of all pig contaminants. DNX Inc, the company involved, projects that it should easily be able to develop swine with fully 50% or more of their hemoglobin being that of the human kind.

HOW DOES YOUR GARDEN GROW?

In a new quandary for strict vegetarians, human and animal proteins

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are rapidly being incorporated into the genetic makeup of several traditional (and some not so traditional) crop plant species. In summer 1991, researchers in North Carolina harvested a partial acre of tobacco that had been genetically engineered to produce Compound Q, currently used to treat AIDS patients. Although not a human protein, this system demonstrates the validity and usefulness of the technology at field production levels.

Perhaps most exciting is the development of what are called "plantibodies." These are human antibodies produced in plant tissues. Simply speaking, antibodies are proteins in animal blood that specifically recognize the presence of "foreign" proteins, most typically virus or bacterial infections. They are what provide us immunity once we have already developed a disease, why we get chicken pox once and never again —because the next time we are attacked by the pox virus, we have developed the antibodies to recognize and help destroy it. There is the potential for using the appropriate purified antibodies, obtained from transformed agricultural crops, as an injected antiserum to attack those disease organisms in people infected by the disease and not already immune. This is especially important for diseases where fatality rates are high. For example, some labs believe that an HIV virus-specific antiserum may be one of the prime hopes in attacking AIDS in already infected patients.

In addition, antisera are one of the most important diagnostic tools currently available because, just as the molecules recognize specific diseases in the body, they can also be used to identify the disease in the isolated blood or tissues of patients. Sometimes quick and sure identification of a disease is the most important step for early treatment. Antibodies are being developed now to recognize the early stages of many human cancers. The vast quantities of plantibodies (literally tons) that may one day be produced may be the breakthrough in both cost and practical utility that these systems need to become available to the greater masses of humanity.

PROMISE AND PERIL

It's easy to see what the major potential increase in human proteins produced by the new gene "pharming" in plants and animals might mean to the future of human medicine. Known pharmaceutical uses of proteins like insulin for disease intervention, and the potential increase in the use of antibodies as pharmaceuticals for treatment and diagnostics, are obvious. These are simply extensions of current practices.

But in scientific progress, as in science fiction, it is the imaginative and the not-so-obvious that often proves most exciting. The biotechnological mass production of these hitherto rare proteins allows for experimentation never before possible.

For example, human growth hormone (HGH) has been touted recently as not only a remediation for dwarfism in man, but for its potential

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effects as an anti-aging compound. A clinical trial of HGH at the University of Wisconsin in 1990 was discussed in the February 1991 *Genetic Engineering News*. It is well known that after age 30, HGH production decreases. Experiments conducted by Daniel Rudman on 21 healthy men between 61 and 81 years showed that, by certain limited measures, including muscle tone, mass, and skin elasticity, their bodies appeared to be almost ten years younger than at the beginning of the six-month HGH treatment. In addition, HGH has shown promise in clinical studies of utility as an anti-muscle wasting treatment. This might lead to long-term potentials to help prevent atrophy in cancer and AIDS patients. Only the genetically engineered, massive increases in the availability of such human produced "drugs" has made possible such breakthrough studies. Many a small farm of the future may turn out to be a multi-million dollar ranch of living pharmaceutical factories to battle disease and improve the human condition. HGH has been produced successfully in bacterial culture, so it is unlikely to be one of the pharmed products of the future. But it can be examined as a model of the effects to come.

Finally, in the field of transgenic plants, new avenues are being explored to tie medicinal qualities to more traditional nutrition. The term "nutraceuticals" has been coined and the National Cancer Institute is now considering programs to genetically engineer foods designed to contain increased dosages of those compounds currently being indicated to have anti-cancer properties. Although the genes used here will most likely be traditional plant genes linked to promoters that will cause super-production of the desired chemicals, other sources of the proteins including animal and microbial are also options. Perhaps super-broccoli or the cancer-fighting french fry may one day grace the world table, thanks to this alternate form of health-related genetic engineering.

Of course, there are caveats to the new technology. Fairly easily dismissed as jokes of the future are questions about cannibalism in eating human-augmented plants and animals. More important are the ethical questions raised by animal rights activists against expanding the use of animals by drastic human intervention. In humanitarian terms these arguments can be answered (of course not to everyone's satisfaction) by the same rationales used to support agriculture in general and routine animal experimentation for medical purposes: the "higher" importance of the ultimate need of the human users coupled to a generalized attempt to minimize suffering in the animals. For example, early efforts to express human growth hormone in pigs led to a number of abnormalities including arthritis, lack of rear leg coordination, and impotence in boars. Although researchers are working to redesign the gene to avoid these problems, the obvious animal suffering is a real issue. Diminution of the suffering and demonstration of the overwhelming human need may be the only counter to

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such humanitarian concerns, as it is with other biomedical research.

Harder to counter may be the more extreme animal rights positions concerning preservation of an animal's unique "animalness" (there usually aren't as many emotional concerns over preserving a plant's "plantness" although, to be fair, there are many philosophical purists) by not tampering with its genetic makeup. These cannot be dismissed out of hand when they deal with issues of real or perceived animal suffering. If we could "build" a beakless, limbless, egg-laying factory-type chicken to fit in our current egg production houses, would that be right or "fair" to the animal? What about legless veal? Or what about just lean pork (since the addition of HGH to pigs, despite the above-named abnormalities, did decrease back fat by nearly one half)?

Perhaps, because of the more important medical issues raised by the kinds of genetic engineering discussed in this article, we might think this technology at least is safer from criticism than suffering caused by genetic engineering simply to increase food production efficiency. But animal experimentation is under attack on all fronts, even that done for the most "noble" medical purposes. Perhaps improvement of microbial and plant systems may ultimately eliminate most need to use animals. But it is unlikely to eliminate all such needs for animal experimentation, if only for model systems of human diseases and scientific advancement, and that is where the animal v. human rights battlelines will remain drawn.

Moral, legal, and ethical objections are also raised to the concept of patenting animals, which industry claims is needed to protect its research investment. Critics claim this reflects human arrogance, though this same argument could apply to all forms of animal ownership, including buying a pet dog. A more lively and economic controversy is developing over the patenting of genes themselves, whether from plant, animal or human sources.

Even the use of microbial and plant systems exclusively will not silence all ethical dilemmas. At the ultimate extreme these can reach the anti-Frankensteinian polemics of "there are some things man was not meant to tamper with." There is often as much anti-science, anti-"Progress" embedded in this position as there is concern for the so-called natural order of things.

Whether modest or extreme, such philosophical and ethical questions, in some cases bordering on the religious, cannot be addressed scientifically but rather by the values of society at large.

On a more practical level there are the typical risks that all pharmaceutical production faces. Proper purification of the drugs produced in these systems is an important consideration. The possibility of contaminants from other animal and plant proteins, including potentially dangerous viruses, carried through during purification is always an issue. As discussed by Jennifer Van Blunt in a 1988 *Bio/*

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Technology article, there is historical precedent for the use of biologically derived protein medicines. Insulin has been obtained from pigs, and various hormones from human blood and urine; and Premarin, a post-menopausal drug, has been isolated from the blood serum of pregnant mares. So purification of drugs from biological sources is not a fatal flaw, but merely a technological hoop like those jumped through many times before by the pharmaceutical industry.

There is some possibility of new allergens turning up in the pollen of transformed plants (a future nightmare, as any current hay fever sufferer would contend) or, much worse, in the purified pharmaceuticals derived from genetic engineering practices themselves. This latter appears to have happened recently with fatal consequences in the genetically engineered production of L-tryptophan (a common amino acid nutrient taken in bulk in health-food supplements) derived from altered microbial sources. Fifteen hundred autoimmune-like illnesses and 27 deaths were reported in the late 1980s. The problem was traced to one Japanese manufacturer. There is no evidence yet that this was a fault caused by the genetic engineering, rather than a subsequent purification step and faults with the drug purity testing standards imposed. But critics are accusing the Food and Drug Administration of failing to provide proper regulatory controls for the edible products of biotechnology and of allowing the first epidemic attributable to genetically engineered materials. As Russ Hoyle comments in the June 1992 issue of *Bio/Technology*, it may be too early for the emerging biotech food industry to commit itself to the FDA's proposed path of least regulatory resistance.

But there are other ethical dilemmas possible. In a more bizarre situation, highly reminiscent of science-fiction scenarios of future drug addictions and future crime, the first of the biotech black market abuses has come to the fore: the use of purified human growth hormone by athletes and weight-trainers as an undetectable-to-referees substitute for steroids, and of human erythropoietin (EPO) as a stimulus to red blood cell production to enhance aerobic performance. Reports in *Bio/Technology* indicate that black market biotech-produced EPO may have been a contributing factor in the death of 18 European cyclists within a four-year period due to blood clots and strokes. HGH appears to be much less dangerous than EPO, and in the black market sells for $500 to $1500 a vial. Unlike EPO, there is evidence that the purported effects on athletic prowess of HGH are spurious, but this does not prevent the criminal abuse.

This minor start in illicit biotech drugs demonstrates the merest glimmer of the potentials for abuse. The eventual black-market potential for untested or unproven anti-aging drugs or cancer cures or AIDS vaccines is a fertile field for future crimes and future human misery. Genetic engineering is not immune to the perils of medical charlatanism, quack-

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ery, and black market drug abuse.

But there is one benefit to future pharming with plants and animals that may prove an unexpected social breakthrough on the level of personal computers or the much-touted global village. The biological fermentors, biochemical reactors, and cell culture techniques currently in use to produce large quantities of many important pharmaceuticals are high-tech systems that are easily controlled by corporations or governments where profit motive can proprietarily restrict the free availability of medicines (irrespective of the argument that it is the profit motive that finances the research that made the drug available in the first place).

But flocks of genetically engineered sheep and fields of transformed vegetables may one day be the equivalent of pharmaceutical power to the people. Picture an illicit peasant-farming economy based, not on cocaine, but on anti-cancer compounds or anti-aging drugs. Purification of the drugs is still an issue, but often a less complex one than production. The proliferation of genetically engineered medicines to the third world, which will probably never have the money to buy them at high-tech prices, may be the only hope of getting this kind of benefit to the masses. In fact, one of the rationales for using plants and animals by the companies currently doing this kind of research is that of cost containment and simplicity.

Perhaps, if there isn't reasonable sharing of technology, one day in the future there will be commando raids on high-tech flocks that will gain some third world nation the sheep or pig or cow or seed that can breed the herds, or found the crops that can transform their whole medical structure to the better. Imagine some future day the benefits of a self-reproducing AIDS vaccine on the hoof to so-called third world nations.

Which, unfortunately, raises more caveats and more ethical concerns, not just those of patent infringements and the marketplace. Better health and longer life coupled to unchecked population growth . . . generations of science fiction writers have predicted that outcome. So, as with all significant new technologies in human hands, the promise and the peril seem dolloped out in equal and heavy doses. In the end, as with all technological advances, society, not science will determine whether the apparently inevitable plant and animal pharming of the future is ultimately a blessing or a curse, or more likely, the standard mixture of the two. ■

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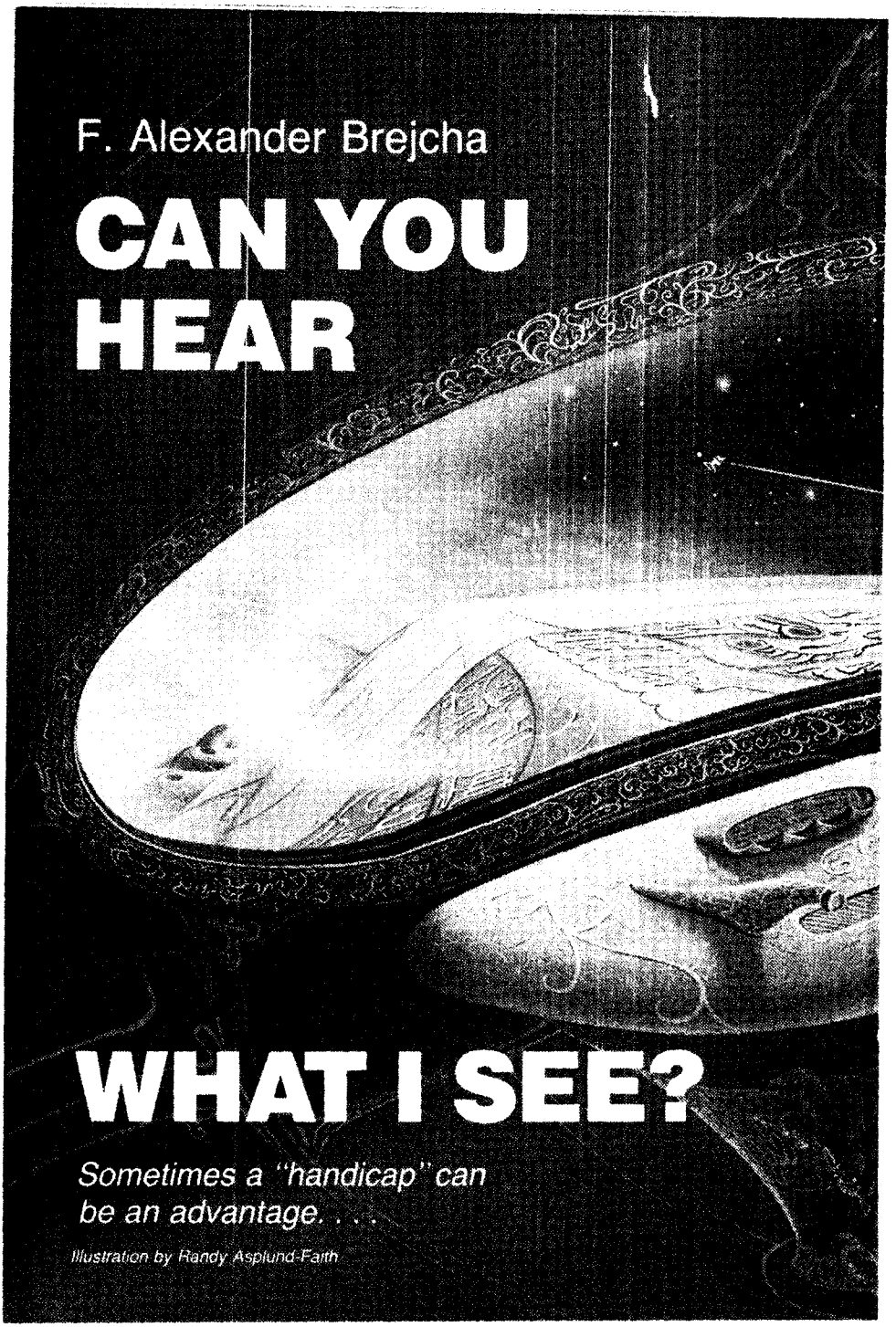
F. Alexander Brejcha
CAN YOU HEAR WHAT I SEE?
Sometimes a "handicap" can be an advantage. . . .
Illustration by Randy Asplund-Faith

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An unseen space-based laser system fired on his shuttle, triggering evasive actions and a barrage of alarms. The automatic controls went off-line and Ahthossio fought the sluggish manual backups. How could he have missed the old defensive satellites? His briefing had warned him of the obsolete anti-missile systems. Now he would have to return to his base ship and face his crewmates' teasing.

Then a one-in-a-million cascade error caused by the laser attack shut down his main computer system. And his engines!

Main power out, his vector and attitude sent him spiraling out of orbit, into the upper reaches of the atmosphere.

He tried the main engines again. No good. Attitude thrusters... he tried to regain control and turn the heat shield to face the planet....

Gradually the shuttle responded and the ride smoothed out. But then, as a ragged mountain range came into view, a damaged stabilizer tore free and the shuttle started to tumble. The crash systems activated to flood the craft with rapidly solidifying foam....

... falling, tumbling...

... dropping...

A numbing impact, and he heard the sounds of tearing metal as pain flooded up and he blacked out....

"Steve?"

The letters scrolled by on the LCD display hanging above his right eye.

"Oh, Doctor Davney?" Alice tried again, her voice prompting a familiar teasing wave-pattern from the stress analysis display.

He closed his eyes.

A gentle but firm finger tapped him insistently on the shoulder. Opening his eyes, Steve saw crisp white slacks. He sighed and looked up to meet Alice's demanding green eyes.

He tried to look contrite. "What?"

"You have three more patients to see," her hands signed rapidly, bypassing his electronic Ears. "*Then* you can ignore me." Her cloud of flame-red hair bounced from the demanding "words," even though her smile took the edge off.

But she was right, and he threw his hands up with a laugh. "I should have known better than to hire my wife as office nurse."

"Hey, you need me." She grinned. "And I need this job to save up for medical school. You're not going to pay my way. You can't afford it yet." She slipped out of the office before he could respond.

Wishing the day was over, he stared absently at the morning newspaper lying in front of him on the desk. "SPACE SHIP CRASHES—SCIENTISTS TRY TO COMMUNICATE WITH INJURED ALIEN." The bold headlines screamed at him.

He snorted. "Good luck! We have enough trouble communicating with each other!"

But he couldn't repress a renewed surge of excitement, even if he had read the piece a dozen times. An alien spaceship! It had come down out of nowhere to crash in the Andes mountains. Response teams had barely reached the ship in time to reseal part of it and replenish the sections leaking internal atmosphere—fortunate,

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since they had managed to save the injured pilot. Details were still sketchy. Unconfirmed rumors had it that the ship had been accidentally shot down, but nothing concrete had been released except that the pilot would live.

What he wouldn't give to be in with *that* medical team!

But he wasn't. He was running late on a more plebeian and overloaded patient schedule. Fortunately he had Alice up front—regardless of what he had just said to her. The clock stared accusingly at him as he ran a comb through his hair. He knew from experience that he had exactly two minutes after Alice's warning to make himself presentable and prepare for his next patient. He had wasted one of them already.

At the expected moment, the door opened and Alice poked her head in. "Tom Bragg's ready in exam room one."

"Thanks." He got up and headed for the exam rooms of the office suite he shared with the three other physicians in the practice.

In room one he found his sixty-eight-year-old patient sitting uncomfortably on the exam table. Tom looked totally ridiculous in the faded blue gown that revealed his knobby knees and scrawny, liver-spotted legs. But his clenched jaw and controlled posture betrayed new pain.

Steve closed the door behind him. "Howdy, Tom. What's wrong?"

"It's the chest again, doc. I don't know if it's my heart, or my lungs, or what. It's hurtin'."

The voice stress analysis scrolled by under the words and he could see how agitated and scared Tom was. He looked over the chart Alice had left, checking her physical exam notes. About what he had expected.

"Did you stop smoking yet?" he asked, already knowing the answer.

"What was—"

"You understood me," Steve interrupted. "My speech is as good as anyone else's now that I can practice with my Ears. Now, did you stop smoking?"

"Sure, doc—"

"You're lying." The speech pattern was unmistakable.

Tom frowned. "You usin' the box again?"

Steve nodded. "Of course. Since I can't hear you—only read what you say to me—I need to know how you sound. For that I need the stress analyzer. Don't you want me to know how you feel?"

"Yea," Tom grumbled, "but I don't like a doctor who listens to me with a lie detector!"

"It's not a lie detector. Just a stress analyzer. Now drop the gown please . . . and hold still."

While Tom untied the straps behind his neck, Steve plugged his stethoscope into the jack on the micro-computer strapped to his belt. After warming the bell, he placed it against Tom's bony back. He wanted to hear the lungs for himself.

"Breathe in . . . and out . . . cough . . . breathe. . . ." The graphic display of Tom's breath sounds as he moved the stethoscope from point to point showed the unmistakable rales and rhonchi of severely congested lungs.

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Then Steve moved the bell around to the front to check out the heartbeat display. He didn't like either picture.

"OK, lie down on your side, please." He went on with his standard exam, step by step, and found exactly what he had expected.

"OK, Tom, all done." He waited as Tom pulled up the gown and tied the drawstrings loosely behind his neck. Then he squatted on a step stool in front of the exam table and looked up.

"I'm going to tell you again, and I'm not bullshitting, you've got to stop smoking! I want you to have a pulmonary function test, and to see a friend of mine who is a heart specialist, but it's pretty obvious what's happening. To put it bluntly, you're in deep shit! And it's nothing new. I told you what was happening the last time, and it's just getting worse."

"You got a hell of a bedside manner, doc!" Tom glared down at him.

Steve shrugged. "Blame yourself. The last time I tried to break things to you politely and sensitively, you reamed me for not being straight with you. Now make up your mind." He matched Tom glare for glare. After a moment, the older man nodded.

"Yeah, I suppose I did, at that. I guess that . . . thing," he nodded at the Ears on Steve's belt, "just makes me uneasy. It's weird havin' a deaf man tell me what he can hear in me."

"I'm sorry, Tom, but I have a responsibility to be the best doctor I can be, and that includes knowing how you feel. Believe me: I don't mean to make you uncomfortable. I just want to help you."

"Yeah, I know. Now get out of here and send that cute nurse back in."

Steve got up and shook his head. Every time it was the same battle: Tom bitched and moaned about the invasion of privacy; then, when told what to do, he kept ignoring the advice. And every time he came in, he was sicker.

It was going to happen again. Tom had been scared, and he had put in his obligatory visit. Now he felt in control again and would blow off the advice until he felt even worse.

The pattern had been repeated often enough.

He sighed and left Tom to get dressed.

Moving on to the next exam room, he scanned the chart tucked into the basket on the door and closed his eyes when he saw that it was Debbie Zylecki's. He was going from the dangerously ill to a first-class hypochondriac. For a moment he just stood there holding Zylecki's chart, trying to summon the strength to go in. Then he forced a smile onto his face and opened the door.

"Mrs. Zylecki! And what seems to be the problem today. . . ?"

Ahthossio was gasping in the thin and foul-smelling air that surrounded him, his frantic breathing causing unbelievable pain. Hovering on the edge of unconsciousness, he strained to see through the crusting film on his eyes. He was lying down . . . in a vaguely familiar chamber. . . . The lounge! He was lying on the "sunning" ledge in the shuttle's lounge. But the sunning lamps were off and

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the only light was a harsh blue-white glare from unfamiliar, alien fixtures that cast ugly shadows over the normally relaxing cabin.

Other strange equipment surrounded him, and as he shifted to look around, he realized that something was restraining him. But the movement brought another wave of pain and he felt the room spiral into oblivion again. . . .

Steve glared at the pile of equipment on the coffee table. The largest component of his Ears, a microcomputer he normally wore strapped to his belt, was no bigger than a paperback dictionary and weighed less than three pounds. Plugged into it, he normally wore a small microphone on his collar which picked up spoken words and turned them into rows of marching letters on the tiny headband-mounted LCD screen that lay next to the computer. When he wore the display, it hung above his right eye so that he could read what others said. His Ears also converted sounds such as sirens, car horns, dog barks, and other programmed input into displayed icons to alert him—icons accompanied by a small warning shock from his watch-band. In addition, the computer translated heart rhythms and lung and bowel sounds into graphic displays that were easy to read and interpret. The system even included a stress analysis routine so that he could gauge a speaker's frame of mind—essential for proper diagnosis.

Everything sat in an untidy pile waiting for him to put it on: the results of collective efforts to mainstream the deaf and hard of hearing.

Mentally, he picked up a sledge hammer and smashed it all into expensive junk. Sometimes he wished he didn't have any of it. Then he would be able to live in blissful ignorance of the noise around him and do something, anything, else to make a living.

Alice moved into view and signed a smiling warning.

"If you break it, vocational rehab won't pay for another one." She dropped onto the couch next to him. "What's wrong? The whole way home, you were totally quiet. I was starting to wonder who was the deaf one in this marriage."

He couldn't manage a smile or answer as letters mixed with symbols to try to draw him out.

"I know what you need." She leaned over and dug in with skilled fingers to massage his tension-knotted neck muscles. Despite himself, he started to relax and leaned into her powerful kneading with a sigh of relief. She moved into his view and spoke clearly so he could read her lips.

"If you could purr, I think you would right now." She smiled and kissed him quickly, then let go, leaving him to collapse backwards. He was finally starting to feel human again.

"Thanks, hon. You're right. I'm not exactly on top of the world right now."

"So, are you going to tell me what's wrong?" She curled up in the corner.

"It's the damn practice," he

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growled. "Every day it's the same. On the one hand I have patients like Mrs. Zylecki with her imaginary problems that I have to cater to because the almighty Dr. Alan Brown wants to keep milking them for every penny possible. Then there are people like Tom Bragg who won't take the advice I give them. As for the kids . . . no, actually, they're OK. In fact, they're probably the best part. But the parents! Always questioning my judgment and 'tolerating' me because I'm the only one who will see their kids on short notice. I'd like to take a few of them and. . . ." He ran down and closed his eyes, his back knotting up again.

A finger tapped him and he opened his eyes.

"So what do you want?" Alice signed. "To quit the practice?"

He stared, and after a moment, nodded. "Yeah. Is that crazy? I can't help it. I want to stop working for Brown."

Alice's eyes dropped and she seemed to inspect her left foot very carefully. Then: "Burnout, huh? I thought I saw it coming. You have been taking a real heavy load of patients."

"Because Brown insists he can't afford to add another doctor to the practice now. He's full of shit. He can afford it. Saul and I are both getting burned out while he's loafing. His load is workable."

He felt bad about dumping on Alice, but he was just so fed up.

Her gaze had dropped again. He leaned over and put a finger under her chin, trying to make her look at him.

"OK hon, what's up?" he asked.

Finally she met his eyes. "Quit the practice."

"You're crazy! How will we live? I have to pay my loans, and we have to pay for your school starting next year. I still want to start our own family practice. Just the two of us."

Alice shrugged. "We'll do it now."

He started to answer, but she put a hand on his mouth briefly and then signed rapidly. "No, listen. Quit Brown's practice and start your own. The money we have saved will be enough if I hold off on med school. I was accepted once, I can reapply. I'll continue as your nurse and keep saving. Then, in a couple of years, when your loans are paid off, I'll take out my own and start school. Then we'll hire another nurse. It just means waiting a few more years for our joint practice. I can wait. We're young. I hate seeing you like this!" Her hands were shouting at him all at once: "It's not you!"

He grabbed her hands and kissed them softly.

"Are you sure?"

She nodded and freed herself.

"Just don't kid yourself," she warned him. "It will probably mean even more work for you—"

"But it will be work for me! For us! Not Brown." He grabbed her and pulled her close, whispering in her ear.

"Thank you!"

The pain was as bad as before, but the air seemed denser, even if it still smelled bad. Nictitating membranes

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blinked automatically to clear his eyes, but as he started to look around, a surge of pain stopped him. Bending carefully, he saw that solid white material of some sort coated and imprisoned one leg and both arms. Were they broken? Finely woven material was also wrapped around other areas of his body, unhealthily sealing away probable injuries.

He remembered the crash. Tumbling, spinning... the numbing impact and blackness.... The natives must have found the wreck. Remembering pictures of how injured natives were treated, he would almost have thought that they were trying to help him.... No. That was totally illogical.

Every contact scenario had indicated a hostile reception if these people were to be contacted without extensive preparation. Their broadcast material made that amply clear. On the other hand, the situation he found himself in coincided unpleasantly well with other media images: images of torture and interrogation. He tried to shift on the ledge, but the pain stopped him again.

Broken in the crash? Or to immobilize him? Further pain from his chest as he breathed warned him that he had broken ribs as well. Short of shackles, he could hardly have been more effectively restrained. The control room, with its communications and control gear, might as well have been back on the base ship.

He had a rush of embarrassment as pressure from his bladder built to the point of release without warning. His pain had distracted him, and he waited, mortified, for the betraying wetness; but felt nothing.

Then he heard a slight trickling sound and managed to look down to see a tube extending up from a container to disappear under a concealing cloth draped over his mid-section. They had anticipated the problem. Gratitude overcame fear. At least he would keep some measure of dignity.

Of course, they had probably done it to make things easier for themselves.

He looked around again and saw that the doorway had been replaced with a bulky airlock. That did not bode well for the fate of the shuttle. If the aliens had resorted to maintaining pressure only in this room, the shuttle had either been severely damaged in the crash, or it was in the process of being dismantled and examined. Either way, he was trapped. It made sense, though. In their place, he would have had experts from a dozen fields crawling all over the shuttle to learn as much as possible about propulsion, computer, and all other systems.

Sounds from the back of the room caught his attention and he looked up....

As Steve turned on the Tri-V, the text-caption on the evening's world news explained that "Scientists are continuing to study the crashed alien spaceship, trying to determine how it flies."

"Not very well," Steve commented as he finished connecting his Ears. Alice slapped him with a "laugh."

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"Hush! Your sister will never forgive you if we're late for her surprise birthday party." She reached for the remote, but Steve stopped her as the picture on the LCD wall screen changed.

"Wait! This is new!"

"... and now here, with our first live pictures of the alien itself—*live,* from the spaceship!" The stress pattern on his display showed the announcer's excitement and Steve sat down on the arm of the couch to watch. He felt Alice's arms wrap around from behind as she propped her chin on top of his head to watch with him.

The three-dimensional image of the recumbent alien seemed to be right in the room, and Steve imagined that he could smell a sharp metallic tang in the air. A measuring rod superimposed on the bottom of the picture showed that the alien was half again the size of a human. It looked vaguely reptilian.

Tyrannosaurus rex, was Steve's first impression—except that the arms were proportionately larger, even disregarding the bulk of the plaster casts that held both arms and a leg immobile. The head was also different. The skull proportions were odd, the snout much shorter, and the mouth lacked the fierce dental armament of the tyrannosaurs. He grabbed the remote control and zoomed in the flat, grinding teeth, realizing this "dinosaur" was a herbivore. He canceled the zoom and looked at the whole creature again.

Shimmering and scaly cobalt-blue skin covered the naked body, lying on its side on a shelf of some sort in a strange, almost cavelike room. A large, heavy tail lay in a limp line behind it. Much of the exposed skin was dull, flaky, and looked bruised. Above the sheet-draped midsection, the abdominal area was covered with large bandages.

This was one hurting alien!

As he watched, two pressure-suited people came into the picture: a man and a woman. The difference in size from the alien was immediately apparent as they nervously approached the reclining figure.

The blue head swiveled, and two black eyes stared out curiously.

Steve couldn't know the alien's feelings, of course, but curiosity seemed logical. A member of an advanced species; a crash and obvious attempts to help? Curiosity would only be natural.

As the massive head moved, Steve blinked. The announcer was continuing to describe the being, but as he spoke Steve's display filled with dithering symbols and an occasional letter in a different typeface from the default one assigned to the announcer.

"Alice?" he looked back. "Is he saying anything?"

"Who, the announcer? Sure, can't you 'hear' him?"

"No, I mean yes. I can see what he's saying. But the alien: is it saying anything?"

Alice looked down at him curiously. "No, of course not. Haven't you read the paper?"

"You didn't hear anything?"

"No." She crossed her heart.

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"Well, someone is." He turned up the volume, stopping when Alice looked nervously towards their neighbors' condo. The second speech track cleared up slightly, and more letters appeared. It was frustrating. Like a crossword puzzle in the very early stages. Without a guide. And without perpendicular clues.

Two complete words stood out from the rest: "...hear me...."

"It's speaking English!" Steve turned to Alice. "Somehow my Ears are picking it up. Just a couple of words and sounds, but I can see it!"

The alien's head dropped and the large eyes closed.

Alice took the remote control and turned down the sound.

"Are you sure?"

"Yes! I'm not imagining it."

Alice just blinked. "OK, so what are you going to do?"

"I don't know. It's not like I can just call the United Nations up on the phone and tell them I can 'hear' the alien. They would just hang up on me."

"So find out who's in charge and fax them on your office letterhead." As always, Alice was eminently practical.

Ahthossio swallowed nervously. Two of the natives were approaching. They wore pressure suits, of course, but through their clear face masks he could see ugly, flat faces with meat-tearing teeth flashing behind fleshy ridges. At least he was safe from their carnivorous habits since his flesh would be poisonous to Humans. He threw himself into Zhuito-ssne *consciousness and focused on the language lessons he had absorbed before launch. He was not supposed to have been the contact person, only a final scout before contact, but he had still learned the primary languages of the planet.*

He forced his mouth to form the difficult and ugly-sounding words.

"I am Ahthossio, I come in peace to meet with your people. Can you understand me?" He began in English. No response. He tried Spanish. Still no reaction. He tried again and again with the languages he had absorbed. But each time the natives ignored him. They stayed at a distance and continued pointing instruments at him. In the background, he saw a large multi-faceted lens aimed at him, a small red indicator light burning above it. Video surveillance, too. He was not to have either privacy or freedom, it seemed.

Frustrated, he tried again in English. Shouting: "Can you hear me?"

The room started spiraling from his efforts and he felt consciousness slip away.

"Explain it again, please." Leah Barry from the U.N. held his fax in her hand as she sat down again behind her desk. "And have a seat."

Steve placed his notebook computer on the desk and opened it so that the LCD panel was visible to everyone. "Do you have a recording of the scene that was playing during the news broadcast?"

Barry nodded but didn't move.

Steve booted the notebook, pulled out a duplex cord, and switched connections on his belt-mounted Ears,

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plugging one end of the cord into his heads-up display and the other to the serial port of the notebook.

"Now, if you'll notice, what I say shows up on here." The words dutifully marched across the LCD panel of the computer. "Well, the day before yesterday, during the broadcast, random letter combinations, scrambled signals and a couple of words—"

"—showed up," Barry interrupted. "Yes, you wrote that you saw the words 'hear me.'" She looked doubtful. "We tried the same test with another set of Sound-Tech's Digi-Ears and got absolutely nothing."

"An off-the-shelf system?"

"Of course."

"Well, that's why!" Steve was relieved. "My set was extensively modified. I'm a doctor, and I had mine reprogrammed and refined for pattern recognition, stress analysis, diagnostic functions . . . a whole range of enhancements. Sound-Tech had to add a stethoscope input and upgrade to a whole new processor to handle the wider frequency response needed for everything. They used an off-the-shelf scientific microphone and sound-processing board to save money. Overkill, but it was the easiest way to give me the frequency headroom I needed." He indicated the larger than normal microphone he wore on his lapel. "It cut the battery time in half, but it's worth it."

Barry brightened and turned, picking up a small Hush-Mic and speaking quickly. The wide screen behind her lit up and they were once again looking in on the alien spaceship. The volume scale on Steve's display showed a low level and he asked Barry to turn it up until it was as loud as it was at their apartment. Then he waited in anticipation as Barry and Alice squirmed.

"Sorry," he offered absently as his eyes scanned the LCD panel anxiously. "Any moment—there!"

On the screen, seemingly random letter combinations appeared, mixed with null characters.

". . . ah . . . sio . . . ese . . . eep . . . and. . . ." Over and over. Strange and teasing blocks, then, right on cue: ". . . hear me?" A definite question. An inflection rise had triggered a question mark.

He gestured, and the image froze into silence. "Well," he challenged. "Now what do you say?"

Barry was cautious. "I didn't hear anything, but I saw what you expected. Assuming this isn't something you've programmed in." She held up a hand. "I'm not accusing you, but I have to accept the possibility. Assuming we can duplicate it, we owe you a definite debt of gratitude—"

"More than that." His earlier feelings crystallized. "I want in on it. I'm a doctor, and I'm used to looking at things from an unconventional angle. I want to be part of the team trying to contact the alien!" He felt his heart racing in excitement. *This* was what he wanted. He saw Alice smiling gently and knew she would support him.

Barry looked a little nervous. "I don't know if there's anything I can do about that. The military is still in charge, and the research teams are totally out of my purview—"

"So call someone," he interrupted.

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"I have some ideas of what's happening and why. I'll be happy to share them . . . if I get to be part of the project."

"I don't know—"

"Wouldn't it be a little embarrassing if I figure it out in front of the world?" he interrupted. "Before your research team does? It would make a hell of a news story."

Barry looked faintly ill as she reached for a phone.

Steve couldn't resist continuing. "Oh, and I'll need my wife as assistant and back-up interpreter. She's an experienced nurse."

"It'll probably pay better than being a nurse in a start-up practice," he signed quickly.

Alice grinned and her hands flashed back. "You're impossible! That's blackmail. But don't let me stop you."

He forced a serious look onto his face as he watched Barry talking rapidly behind her telephone Hush-Screen. He quickly gave up trying to read her lips, her mouth was hidden half the time and she was talking too quickly.

Alice's hand sneaked up to squeeze his, her eyes sparkling. She was leaning forward, obviously trying *not* to look expectant. But she failed miserably.

Barry hung up the phone and turned back to them.

Ahthossio didn't know how much time had passed, but now there was only one of the natives: the smaller female. He remembered his anatomy briefings, and the differences between the sexes was obvious in most cases, even under pressure suits. It was not merely a matter of anatomy, but also the use of artificial pigments for decoration.

"Can you hear me?" he tried again. He called out twice, then stopped, embarrassed. He had just remembered that the natives' auditory spectrum was below his unaltered speech and that his frequency reducer was in the control room! They couldn't hear him.

The second native from before returned to the lounge, followed by a new one; another female. He strained his ears as he saw their mouths moving. Ahthossio realized suddenly that what he had taken to be mechanical and background noises were in fact words. He couldn't understand them, but they were real. He felt like roaring with frustration. If only his arms had been usable, he could have found some way of writing a message, even if his writing skills were poor. Since he was just a scout, he had not been given more than basic training in Human writing. But there had to be some way to make contact!

Then he remembered his clutchling days and the secret language his clutch had devised. They had trained themselves to lower their voices and invert the word structure. It had been useful in their secret raids to paint marks on unhatched eggs in the nursery. It had also been useful later, when two of his clutchmates had been in the same Intermediate Learning class in pilot training. The female trainees were housed in a different complex, and planning raids there had been even more entertaining.

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Those old tricks of lowering his speech frequency might be useful here, he decided. Dropping into Zhuito-ssne *again, he concentrated on altering his voice as much as possible. He forced his throat and larynx to try to duplicate the low-speech phrasings, twisted even more by the alien language.*

"Can you understand me?" he tried.

The female who had approached him cocked her head and spoke rapidly to the others, who nodded.

Did they understand him? He couldn't make out what they were saying.

He tried again. "I am Ahthossio. I am here on a peaceful mission. Can you hear me? Just write your answers down. I can't hear you."

"Well," Barry said reluctantly. "It seems that you two are now part of the Alien Task-Force." The words seemed to taste bad to her.

Steve leaned forward.

"Thank you." He held out a hand. "Can we start over? I'm sorry about bullying my way onto your team, but I'm proud to be part of it and I'm looking forward to working with you."

Barry hesitated and then took his hand.

"Let me guess. You've been a science fiction fan for years and this was just too good a chance to pass up?" She chuckled at his nod. "Well, I guess I can understand it. Now what's your idea?"

"Just this," Steve began. "One of the ways my Ears was modified was to extend the frequency range and sensitivity to pick up and distinguish the various sounds I need to hear. Actually, a great deal more than I really need. But it gives me some advantages. For one thing, I don't need a doppler to hear faint pulses because the combination of my stethoscope and Ears is just as sensitive."

He indicated the still-frozen image on the wall screen behind Barry.

"I want to run this tape through a spectrum analyzer. I have a feeling that the alien's speech is either very high frequency or very low frequency. My guess is that it's outside our audible spectrum and just borderline for my improved Ears." He stopped for a moment, getting excited. "Or, it could be that my Ears are good enough but that the recording isn't. We need to test the Ears live!"

Barry was nodding. "Makes sense. The alien's been drifting in and out of consciousness, but once when he woke up, Joan—Dr. Morris, that is, who heads the medical team—reported that he made some very high, squealing noises. It was nothing they could understand, but it was the first sound they had heard him make. Dr. Morris is there with him now, along with an assistant and one of our contact people, and I'm sure they'll be happy to get your help. She's frustrated because the military won't let in a full-fledged research team. Apparently the big brass are still worried about the alien holding us responsible for the crash and any massive research presence scaring him . . . or provoking him. We don't know if he

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might have weapons we're not aware of. . . ." Barry's voice trailed off and she held up a hand. "I know: it's ridiculous. But let me make a few calls."

Ahthossio felt like roaring. His alien captors must be incredibly stupid! He had tried the most basic possible way of establishing contact, but nothing had worked. He was limited in what he could do since they couldn't hear him, but if they had any brains at all, surely they would have been able to figure out the numerical progression of prime numbers he had worn himself out tapping with his uninjured leg.

Actually, it had made him roar—in pain. The movements had aggravated his injuries. And made him angry.

Where were the scientists he had expected to meet?

The alien shuttle had been sealed off from prying eyes by ten-meter high fencing and forbidding armed guards. Inside the fence, Steve got his first look and marveled that the pilot was still alive. The shuttle's bow and belly were badly gashed and ripped open from the crash-landing, but the upper part of the ship was relatively undamaged—and that was where the rescue teams had found the pilot. As he entered the craft behind Alice and Maria Canova, the U.N. contact person, Steve felt as if he was ten years old again.

Everything was scaled to someone considerably larger, and he looked up and around in awe. The color scheme, odd-looking signs, and larger scale, all reminded him that this was an *alien* ship. Alice held his hand tightly, craning her head as she looked around with a wide grin on her face.

"Look at all this," her hands flashed as she released him for a moment. "It's incredible!"

Steve reclaimed her hand and squeezed in agreement as Canova looked back at them.

"Ms. Barry told us about your theory, and Doctor Morris and Doctor Schindler are looking forward to seeing a demonstration. The alien seems to be healing well, but he is getting more and more agitated. He's probably trying to contact us somehow, but we can't understand him. And because both of his arms are broken, he can't activate whatever computer systems he might need to communicate with us."

"Well," Steve responded. "Let's see if my idea works."

As they headed deeper into the shuttle, he noticed Alice frowning and thought he knew why. It bothered him, too. Halogen flood lights had been set up at regular intervals down the corridor, and their harsh glare seemed to violate the muted colors and gentle curves they saw all around them. He couldn't see a single sharp angle anywhere. The corridor walls blended smoothly into the ceiling, and the archlike doorways were decorated with filigree engraving that reminded him of the vines covering the trees in their own backyard. On the walls, beautiful and intricately engraved decorations surrounded what he presumed were intercoms or control panels. Running his fingers over

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them, he noticed extra details he had missed at first under the glare of the flood lamps.

He called out to Canova. "What do you think about the engraving . . . hell, just the look of the ship?"

Alice was right with him. "Really! Hardly looks like something 'Killer Lizards From Outer Space' would be flying, does it?" She had been admiring one particular engraving and ran her finger over it. "This is beautiful! Do you see all these details?" Her eyes popped wide. "I hope you don't have this type of light on the pilot! I'll bet their eyes are a lot more sensitive than ours."

Canova looked surprised for a moment. "Not quite, but you know, more acute eyesight makes sense." She turned and hurried on down the corridor. "Come on."

Steve grinned as he grabbed Alice's hand and followed.

"Damn right! I have a feeling this is going to be real interesting. I wonder if he likes Mozart?"

He stared. "Who?"

"The pilot, dummy." She smiled. "Well, soft colors, delicate engravings. Hardly seems like the heavy metal music type, does he?"

He laughed. "No, I guess not."

Canova had stopped and Steve saw a short, blond woman in her late forties come out of an open doorway.

"Welcome aboard, Dr. Davney, Mrs. Davney. I can't wait to see what you have planned." She paused a little uncertainly, glancing from his head display to Alice.

Steve smiled. "Thanks, but I hear you fine, thanks to this." He indicated his headset. "That's why I'm here."

Her face reddened and he laughed. "Relax. I'm Steve and this is Alice."

"Hi. I'm Joan. Karl is in with our visitor right now, trying to get him to eat." She eyed the headset and the device on his belt. "Ms. Barry told me a little about your Ears, but would you mind running through it yourself?"

"Sure." He gave her his well-rehearsed and often repeated speech on how the Ears worked, and how he hoped to use them to hear the alien speaking. And, with a smile, how he had gotten assigned to the team.

Joan chuckled. "Don't feel bad. My ex-husband is on the appropriations board, and I more or less blackmailed him into forcing me onto the project. Seems like we went to the same school of persuasive speaking."

Alice couldn't contain herself. "Where is the alien?"

"Right down there." Joan pointed down the long central corridor of the shuttle, towards a bulky airlock added over the last doorway. "It's the only part of the ship still pressurized with its native atmosphere." She looked at their anxious expressions and grinned. "I have a feeling you folks are ready!"

"More than ready!" Steve and Alice burst out simultaneously.

"Well, in that case, let's get suited up and in there."

Hunger was starting to compete with pain, and obviously that had been on the minds of the Humans too. Even if they had not found the shuttle's regular food stores, they had

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started to bring out a selection of plants from the supplemental hydroponics tanks. One after another, the single male observer from before had been offering them for Ahthossio's inspection. So far, the plants offered were still from the medical section, but he could see food plants waiting in line. Their proximity was incredibly frustrating.

As a gastric relief plant was removed, four natives entered the now-crowded lounge through the airlock. The females from before, a new female and a new male. The latter had a strange-looking device strapped to his helmet over one eye and another device strapped to his belt. He lifted a small rod towards Ahthossio.

A weapon? Ahthossio fought a brief flash of panic, but then he noticed that the same type of cord that connected the rod to the belt-mounted box also connected the box to the device over the Human's eye. Could the rod be a microphone and the box some sort of translator? Another attempt to communicate? Perhaps they had heard his earlier greeting. He repeated it again.

"I am Ahthossio, I come in peace to meet with your people. Can you understand me?"

The male with the device turned to the others and Ahthossio heard a rush of low-frequency rumbling. Had they finally heard him? The man moved closer, making some adjustments on the box he wore and then waved as if motioning Ahthossio closer. Did he want Ahthossio to speak again?

In case that was what the Human wanted, Ahthossio repeated his greeting again, speaking as clearly as possible—and with a growing sense of hope. Perhaps they were more intelligent than he had thought?

The male's eyes were wide as he dropped the microphone and turned to the others, speaking rapidly.

Impulsively, Ahthossio tried something else.

"I am extremely hungry. These plants you have been offering are medicinal. The food plants are the six at the end."

Did they understand him?

The Human with the microphone clipped it onto the box at his waist and went over to the food plants. He grabbed a couple of them, and put them right in front of Ahthossio. Then he started to back away, but stopped and moved close again. Carefully, he extended his gloved right hand and held it out to Ahthossio.

Remembering the video records of human social interaction that he had viewed, he forced himself to ignore his pain and moved one cast-covered arm forward so that his hand was closer to the Human's.

Skinny gloved fingers reached out after a moment, and closed briefly over Ahthossio's hand to squeeze lightly before letting go.

Ahthossio fought dizziness from the pained exertion to say: "Thank you."

Behind the transparent face-mask, the Human's face twisted to reveal teeth briefly, but this time Ahthossio wasn't worried. He knew that it was a smile. ■

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THE ALTERNATE VIEW John G. Cramer

SCIENCE POLICY: THE PARABLE OF THE KING AND THE HARVEST

I'm an experimental physicist. The basic physics research I do is funded primarily by the U.S. government. As I write this, it is less than two weeks before the 1993 presidential inauguration. The new Clinton Administration is still an unknown quantity. A new presidential science advisor with excellent qualifications, Dr. John H. Gibbons, has just been appointed, but little is known about the science policies of the new administration.

In the U.S., almost all basic research in science is funded by agencies of the federal government, particularly the National Science Foundation (NSF), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the National Institutes of Health (NIH). The previous experience of scientists with the start-up science policies of incoming administrations, unfortunately, has been largely bad. The Johnson Administration started by raiding science budgets and canceled many new science and space projects to pay for the Great Society. The Nixon Administration never even bothered to appoint a presidential science advisor. The Carter Administration diverted massive funds within the DOE from basic science to initiatives for "politically correct" energy sources, unofficially known within the DOE as "sunbeams and windmills." The Reagan Administration initially killed all science education funding at the NSF because, it was claimed, the NSF education program in anthropology was promoting "cultural relativism." The Bush Administration's secretary of energy, a retired admiral, effectively shut down basic research at all of the U.S. National Laboratories for six months or more while "tiger teams" of retired military officers and others prowled them for possible safety hazards, demanding vast mountains of new paperwork from the unhappy scientists.

What is next? A dangerous new "fashion" in science policy has been in vogue in Washington for the past few months in certain congressional committees and in the upper man-

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agement of the National Science Foundation. It is to turn away from basic research and fund technology transfer and "relevant science," i.e., scientific research that is said to be directly connected to technological progress and industrial applications, that might be useful in developing new products for industry.

This simplistic policy is very much like Exxon deciding to drill only producing oil wells, or a book publisher deciding to publish only best-sellers. A recent NSF advisory group composed of executives from technology-based industries recommended, to the dismay of NSF leadership, that the NSF should not pursue such a plan. The best vehicle for technology transfer, the panel members asserted, was "the moving van that transports the new Ph.D. from his university laboratory to his new job in industry." It remains to be seen whether their advice will be heeded.

This brings me to what I wanted to present here: a way of thinking about the problem of science funding. It is in the form of a parable, a story about the king of a city-state in Mesopotamia around 3000 B.C., a time when life was simpler and harsher and what we call civilization was just getting its start.

During the first year of his reign the Great King Zaggisi, new ruler of the city-state of Ur in the fertile crescent formed by the Tigris and Euphrates rivers, was presented with the problem of how to allocate the grain from the previous year's harvest.

Fortunately, Zaggisi had a Gift. He had received it as a young man, well

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before his ascension to the throne of Ur, probably from a god. He had been fighting for his life in a mighty battle with warriors from the neighboring city of Nippur. He was wielding his bronze sword from his chariot, riding close to his father, the King. A lowly slinger, a peasant foot soldier of the enemy, had hit him in the temple with a stone, and he had fallen into unconsciousness.

He had awakened a time later, lying on the ground in the mud and blood among the dead. As he stood, sick and dizzy, he discovered his Gift for the first time. He found that as he looked around, he could see not only the battle that still raged on around him, but its future courses and its possible outcomes. Glowing swaths marked paths along which the battle might progress and highlighted places at which it might ultimately reach its climax.

Young Zaggisi moved across the battlefield to a hilltop, the place from which he saw that the battle could be won. There he stood and shouted the battle cry of his royal house. Foot soldiers collected around him. His father and the royal charioteers joined them. From this high ground, with the royal forces of Ur gathered and focused, they punched forward and downward, dividing and routing the enemy. In an hour, few of the enemy were left alive.

Zaggisi, not the oldest of the many royal princes, had from that day been his father's designated heir. He had never told anyone about the Gift, the extrapolative sense that allowed him to peer into the future, to see the consequences of any act. Now he gathered around him his Council of Advisors, the wise of the city who traditionally advised the High King on his most weighty decisions. Today he needed to decide the allocation of the bounty from the year's harvest, the plan by which essentially all of the portable wealth of Ur must be distributed by his new administration.

The head priest and leader of the Council of Advisors came before him first. "Great King," the old priest said, "it is the advice of the priestly class that you use all of the year's grain to erect a great temple to the great god Enlil, who has given us this bounty."

Zaggisi concentrated, his Gift showing him the consequences of this course of action. A temple of great beauty would rise, and for a time the large expenditure on public works would create prosperity in the city. But at the end of this shining path was a black cloud. There would be a crop failure, the starving poor would riot, and they would be joined by dissatisfied soldiers. In the far future travelers would find the great building in a wasteland and would marvel that any king would choose to build a great temple in such a desolate place.

The priest was followed by the leader of the military, who advised the king to use most of the year's grain to hire artisans to construct new weapons and hire additional mercenaries to use them. He promised that the conquests of neighboring city-states would generate rich plunder that would more than compensate for the expense.

Zaggisi saw the consequences.

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There was a fork in this path, with one narrow branch leading to conquest and riches as the man had promised, but the other, wider path led to defeat, starvation, death, and chaos.

The third advisor was considered a saint among the populace of the city. He had been born into a wealthy family, but had given all his wealth to charitable and deserving causes. Now he advised the king to use the previous year's harvest to feed the poor, to care for the sick, and to provide adequate housing for all. Zaggisi examined the consequences of such generosity. It was a disaster. At first the poor were better off, but in the course of two years the crops would fail, the city would fall, and the majority of the present poor would be dead or enslaved.

The stream of advisors continued. Zaggisi was advised by the leader of the construction guild to build more roads and highways. His Gift showed him that transport was important to his city, but not of the highest priority. He was advised by the most cautious and miserly of his citizens to hoard all of the year's crop in that great city storehouse against the possibility of hard times to come. The King saw that the principal consequences of this would be to provide a great feast for the rats that infested the storehouse.

The next advisor was Zaggisi's keeper of records, a man known for his devious cleverness. "Master," he said, "I have a wonderful idea. We will sort the kernels of grain into those which are of the best quality, and those of lower quality. The high quality kernels we will use for seed, while the lower quality we will distribute equally among the uses that your other advisors have advocated."

The King used his Gift to consider this advice. It showed him that the external appearance of a kernel of grain was not a predictor of its likelihood of success as a seed for next year's crop. The plan would result in a massive human effort, accompanied by much pilferage by the large army of grain inspectors, with no positive result in the improvement in crop quality.

The last advisor was the King's agricultural minister, an old farmer and a longtime friend of the King and his father before him. "My son," he said, "all of these worthy men have found excellent uses for the bounty that the Earth has provided, but none have given a thought to returning to the Earth a share of what it has provided. Your highest priority should be to invest in the future by providing enough seed grain to match that which seeded this year's harvest, plus an additional increment to increase the size of the harvest. When this is done, you must use your judgment to determine which of the other worthy causes require investment in what amounts."

Zaggisi explored this advice carefully, and found it to be excellent. Grain has many uses. It can be used to feed the poor and gain popularity. It can be used to hire mercenary soldiers and expand the military power of the city. It can be used to hire arti-

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sans to construct new civic buildings and decorate them with great works of art. It can be used to hire workers to improve the streets and highways of the city. It can be kept in the great storehouse of the city to increase the city's wealth. But above all, a sufficient quantity must be returned to the farmers as seed-grain for the planting of next year's crops, or the city will fall.

That's the parable. In considering its implications, you might carefully examine the origin of many technological marvels that shape our lives. VCRs and smoke detectors, MRI scans and home computers, microwave ovens and communication satellites, antibiotics and jet airliners. None of these depend on some single breakthrough discovery. All are possible because of an accumulation of knowledge and discoveries from a broad range of disciplines.

Consider, for example, the smoke detector. It depends on previous scientific investigations in nuclear physics for the discovery of the transuranic element Americium used to ionize air in the device, on work in condensed matter physics for the discovery of semiconductors and transitors of the integrated electronics it uses, on work in gas dynamics that brought understanding of the transport of electrically charged smoke particles in a non-uniform electric field, and so on. The scientists who made these discoveries were doing their work for a variety of reasons, but I think it is safe to say that none of them had in mind the development of a smoke detector or were motivated by considering the lives that such a device might save. Few would have even been able to predict that their work would have important consequences. Most were simply trying to gain better understanding of some aspect of the physical Universe. And yet, the cumulative result of these diverse scientific efforts has resulted in a common device that, over the years, has saved a great many lives.

The seeds of scientific investigation flourish in ways that are not possible to predict, except in very general ways. No one is able to anticipate that a particular investigation will lead to a particular result. And yet, we can assert with confidence that the overall enterprise of science will lead to new knowledge and understanding, will provide the basis for new technologies that we cannot even imagine.

We must invest in basic research on a broad front to insure that each "crop" of new knowledge brings its bounty in new technologies and innovations. Our seed grain must be protected and used to ensure the bounty of future harvests. ■

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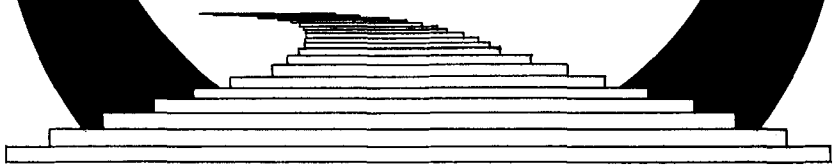

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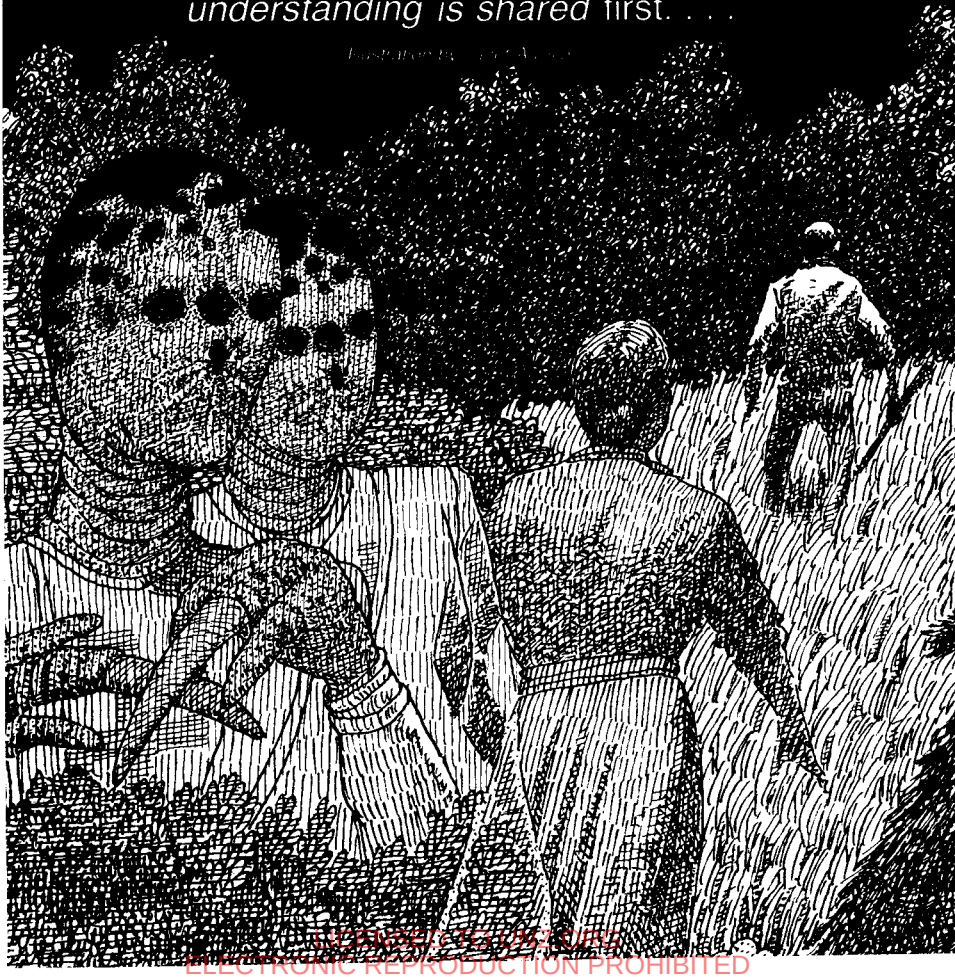
BURIAL DETAIL

Grey Rollins

Symbols are to communicate—but unless a certain amount of understanding is shared first. . . .



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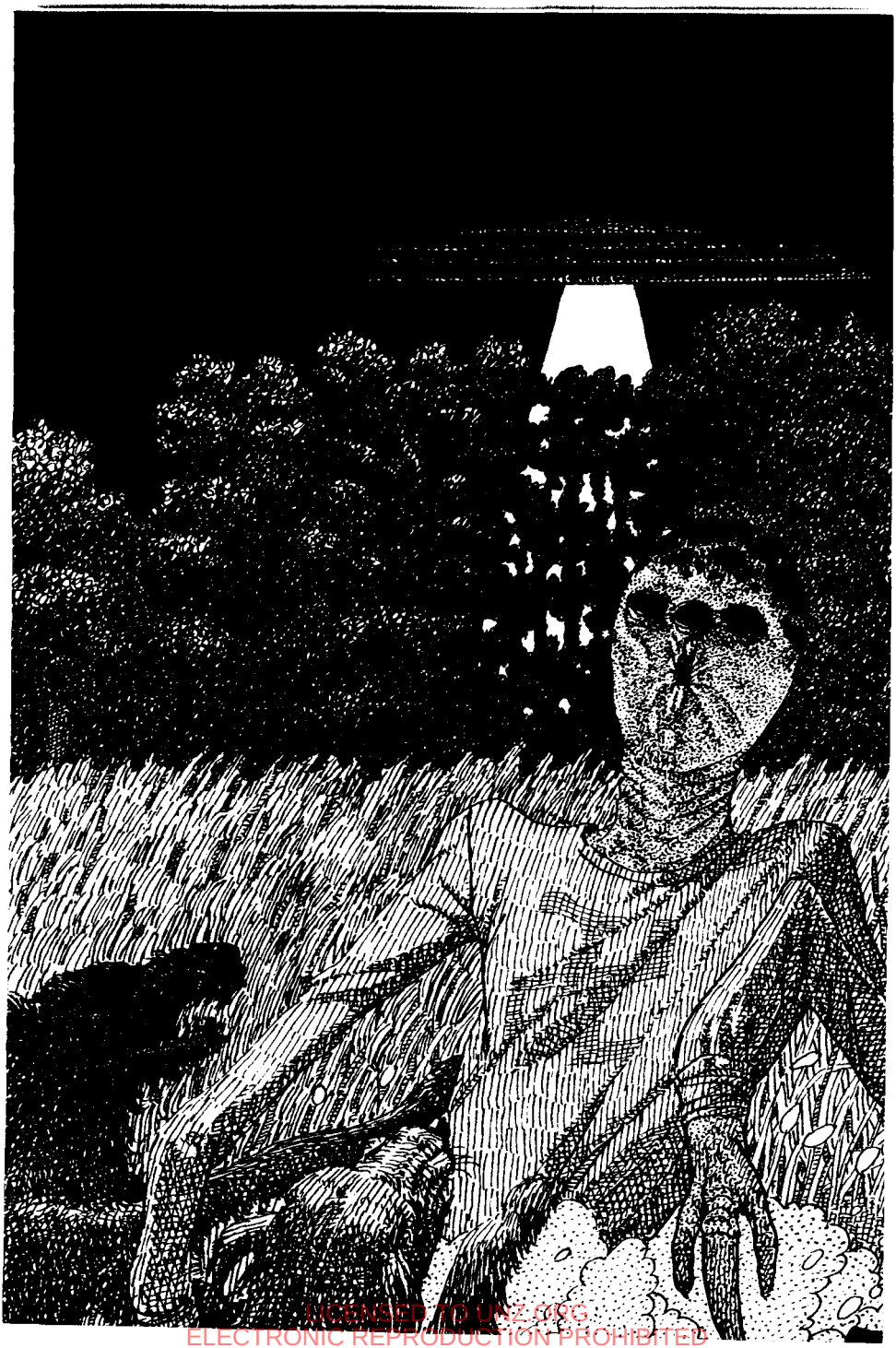

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August 24, 1942

Jasper Hudson sat on the front porch looking out across the tops of his corn. Late afternoon sun slanted across the field. Rain had been scarce these past few weeks and the leaves were parched and dusty. It was easy to see that there was not going to be much corn this year. Tomatoes, potatoes, and beans were doing poorly, too.

"Emma!" he bellowed.

"Yes?" His wife's voice floated back out through the rusted screen door.

"How much you got put up for this winter?"

"Some."

"Some? What's that mean?"

He heard her footsteps approaching as she walked across the bare wooden floor. "Means more than a little, but not enough." She stopped just inside the door, drying her hands on a threadbare towel. "Not as much as I'd like to have, this time of year. About the only thing we've got enough of is apples. There's still some left over from last fall."

Jasper pulled his glasses out of his shirt pocket and began to chew idly on the end of the temple piece, something he often did when he was thinking. "Reckon I'd better start lookin' for some money, then. That corn," he waved the glasses at the stunted growth in the field, "ain't going to amount to much."

He heard her inhale sharply through her nostrils and knew what was coming. "Now, Jasper, I don't want you fixin' up that still! You let that be."

He grimaced. She'd read his mind with perfect clarity. "Well, dammit, woman! What do you want me to do? We're going to need to buy extra food this winter, and to do that we'll need money."

"The Lord will provide," she said calmly, and walked back to the kitchen sink.

"Helps them as helps themselves, was the way I always heard it," Jasper muttered to himself, watching a red-tailed hawk ride a thermal. He thought about shooting it. What few chickens he had were not intended for hawks to eat.

Before he could complete the thought, the hawk suddenly wheeled, seemingly standing on one wing tip. It dived, arrowing for the far right corner of the field, back where the potatoes were struggling. Jasper squinted, trying to pick out what it was aiming for. He saw it just before the hawk struck; too dark to be a squirrel, and it moved wrong. Then it was swinging under the hawk's ascending body, impaled by the talons.

Just behind where the animal had been, the needles of a small black pine swished, and a very tall, thin man stepped out, staring after the hawk. Jasper Hudson's eyes fell on the newcomer, then widened. "*Jesus!*" He shot to his feet, hands braced against the wooden rail of the porch, neck thrust forward.

The stranger's head jerked towards Hudson. In one flowing motion, he whirled and ran back into the woods. Hudson wasted several seconds staring open-mouthed at the trees where the intruder had been. Then, belat-

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edly, he remembered the glasses dangling from his hand. He jammed them on his nose.

Too late. There was nothing left to see.

He shouted over his shoulder, "*Emma*, get my gun!" and jumped off the steps. There was a dog asleep under the porch, taking advantage of the shade. He thumped the dog's flank with the toe of his shoe. "Git out of there, dammit! Move! Now!" he bellowed.

The dog stiffly got to its feet, then dodged as Hudson kicked at it again. "Go!" The dog just looked at him. He picked up a stick and threw it as hard as he could towards the corner of the field. The dog was just loping when it entered the field, but as it neared the spot where the stick had landed it stopped, ears perked. It took off into the woods barking, making good time.

Another dog came out from behind the shed which sat off to one side of the house. It barreled into the trees, aiming for the barking of the first dog.

Hudson heard the screen door slam behind him. His wife wordlessly handed him his rifle. He took one look at it and swore. "I want the shotgun, not the rifle."

"Well, you didn't say!"

He pushed past her and bounded up the steps. In moments he was back, carrying the shotgun in one hand and three shells in the other. He started down the steps, lost his footing, tried to grab at the rail, but the shells kept him from getting a grip and he fell heavily on his side, bumping down each step to the ground.

"Jasper!" his wife cried. She moved towards him.

"*Ow!*" he yelled. "Leave me be." He painfully pushed himself to a sitting position, breathing heavily. It took a minute for him to catch his breath. "I think I busted somethin'," he gasped, holding his side. "It hurts to breathe."

"Let's get you back up on the porch."

"I got to go with the dogs."

"You ain't doin' no such thing, Jasper, you just said yourself that you're hurt."

"But—"

"The dogs will be fine, just let them run."

It was impossible to make good headway running upright through the forest. The creature unfolded its forelegs and dropped to a four-legged gait. Not only were four legs faster than two, but having a lower profile reduced the number of tree limbs in the way.

Behind, the frantic yelps of dogs on a hot scent struck terror into the creature's mind. It had never seen dogs before, but there was no mistaking the teeth of a carnivore. Any creature that made that much noise was clearly near the top of the food chain. No prey animal would be foolish enough to advertise its presence in such a manner.

The creature was built only for short bursts of high speed and it quickly faded from aerobic to anaerobic metabolism. As fatigue poisons built up, the lead that it had over the dogs began to diminish. The baying drew closer.

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There was a small pond ahead. Where muscles failed, perhaps strategy could succeed. The creature staggered through the heavy brush surrounding the pond and splashed into the water, sending gouts of water leaping into the air as it plunged in up to its hips.

Exhausted and terrified, it turned to face the shore just as the dogs burst through. Without pausing they closed for the attack. The creature, seeing this, knew that it had lost the gamble. It folded its forelegs and drew itself to its full height. Filling its lungs for the last time, it released a long, winding ululation that curled through the air like a siren.

The dogs, stunned by the pure force of the cry, fell back in confusion. The creature pushed towards the shore, faintly hoping that it could make a successful break for safety.

The dogs surged forward, closing from opposite sides, driving their prey face down into the water. Their teeth tore at the creature's flesh. Agonies unimaginable burned acid holes in leg muscles ripped and bleeding.

Death came in stages. Pain became distant, then faded as nerve junctions ceased functioning, mercifully leaving the neural circuits open. The last conscious thought was of the need to breathe, as water flooded its airways. Blood loss eroded the creature's ability to keep track of its surroundings. Then the creature sighed as the chest musculature failed. The last air in its lungs bubbled to the surface of the muddied, bloodied water, and the three violet eyes closed forever.

* * *

The creature's call echoed eerily through the valley. Sweeping across the wooded slopes, it reached the ears of the three creatures working a bank of ferns. As one, they stood, heads swiveling to locate the source of the sound. They listened. The sudden cutoff of the cry told them that it was too late to help their comrade.

Without looking at one another, they rapidly gathered their tools and instruments, stuffing them quickly into fabric bags that lay on the ground next to their feet. As soon as they had finished, they slung the bags across their shoulders and loped around the mountain, maintaining the same altitude, as though describing a topographic contour with their path. The ship was not far away and they reached it unmolested.

Another was outside the ship, waiting. "Tastnest?" *he inquired.*

"Death-cry," The first returning creature affirmed.

"His moleana?"

"We heard nothing, but Tastnest had his moleana *with him when he left us."*

"We must assume that they are both lost," the one standing next to the ship said.

"The moleana *too?" asked the second of the returning party.*

The one at the ship chose his words carefully, for Tastnest had been one of Salo's breeding group. To lose Tastnest was bad enough, but to lose the moleana *as well would leave the group effectively sterile. "It is too dangerous to try to locate the* moleana. *Any predator capable of killing Tastnest will have had no trouble*

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with such a small creature as a moleana."

Emotion and logic warred in Salo's words, "But the rituals!" she protested. "At the very least, we must complete the rituals."

Brasnet, the one who had remained with the ship, said, "To complete the rituals, we must have Tastnest's remains. To search for the body would be too dangerous with predators about."

"Not to complete the rituals? But such a thing has not been done in twice a hundred lifetimes!"

"We cannot go for Tastnest's remains!"

"We must!"

Brasnet countered, "If a predator were to catch us, then who would complete the rituals for us? Then there would be five incomplete lives, not just one. We must take the path of lesser alolo."

Salo passed a forelimb across the thigh of her left leg, a gesture of submission under protest. "Lesser alolo *will prevail."*

The breach of tradition was weighing heavily on Brasnet, too. "I do not wish to leave Tastnest's life incomplete, Salo, but I cannot risk further loss of honor."

Without replying, Salo dragged past Brasnet and entered the ship. Muted clicks told of emotional pain unendurable.

"I believe we could triangulate Tastnest's death-cry," one of Salo's two companions offered.

Brasnet blinked all three eyes in succession. "True?" then turned to the other and repeated, "True?"

"Possible. We would enter rapport and replay each perception of the direction of the death-cry. Knowing where each of us was located at that moment should allow us to triangulate Tastnest's remains."

"If there are any remains," Brasnet said.

"You are too saa."

"I was designated leader of this expedition." Brasnet pointed out stiffly. "If I have chosen unwisely, then I will take responsibility."

"That you will."

Jasper Hudson breathed as shallowly as possible. It lessened the sharp pains in his side. Walking carefully to the screen door, he peered out into the gathering dusk. "Where *are* those dogs?" he fumed.

Emma shrugged. "Maybe they chased farther than you thought. It may take them a while to get back."

"Not this long."

"Well, what are you saying then? That you want to go look for them? You can't hardly walk, Jasper."

"Yeah, I can."

"And carry your shotgun? Let me see you pick it up."

Defiantly, he reached for it. As his fingers wrapped around the barrel where it stood propped next to the door, he winced, cursing under his breath. The barrel slipped from his grasp and the gun slid down the wall to the floor.

"Try that again and the blessed thing is liable to go off," his wife scolded. "You'd better set yourself down," she added, seeing the sheen of sweat across his forehead.

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"I'm watching for the dogs."

"You never watched for them before. A month ago they were gone for three days and you didn't so much as spit. What's got you so worked up, anyhow?"

"Nothing."

"Jasper, don't tell me 'nothing' like that. I've been married to you thirty-six years and I know better. Why did that man bother you so? He didn't say anything, did he?"

Jasper Hudson slowly turned to face his wife. "No, Emma, he didn't say anything."

"Then why did you call for your gun?" she demanded, nodding towards the floor where the shotgun lay. "I declare, *something* got you stirred up about him. I don't recall ever seeing you react like this before."

"He was a German, Emma."

Her eyes narrowed. "A German . . . *here?*"

He nodded. "I saw him."

"That don't make no sense, Jasper."

"I saw him," he repeated.

"How'd you know he's German?" she demanded. "He talk at you?"

Jasper shook his head. "I told you he didn't say nothin'."

"Then how'd you know?" she persisted. "They're not like the Japs —they don't look any different from us."

"He had a," his hand made angular cutting motions in the air, "thing on his shirt . . . swastika."

Emma studied his face carefully, noting his pale complexion and the sweat that beaded his brow. "You sure you didn't crack your head when you fell?"

"No, I didn't hit my head!" he replied testily.

"Well, it does seem a little odd that a Nazi would pop out of the woods on a farm in the mountains of North Carolina."

"I'm telling you, he had a swastika on his shirt!" Jasper bellowed. "*Ow!*" he cried, clutching at his side.

"Nazi or no Nazi, I've got to get you to a doctor. You've broken some bone in your side. A rib or something."

"It's near dark, and I want to be here if the dogs come back."

"You're afraid that your Nazi is going to come here," she said.

He started to deny it, then gave a small sigh. "OK."

"You're serious. You saw a Nazi out in our field."

"That's what I'm tellin' you, woman. He had a swastika on his shirt."

"If you're right, then we need to warn the Peytons and John Small."

"It'll have to wait until morning, 'cause you aren't going down that road in the dark alone, and I can't go with you with my side like this."

Emma bit her lip, weighing the alternatives. If she went, she could not only warn their neighbors, but she could send for the doctor. On the other hand, the idea of traveling the lonely dirt road that led down the valley filled her with dread. "All right. We'll sit up tonight. You set yourself on that chair and rest your side. I'm going to hold the other gun. If any Nazis come here tonight, they'll get a little warmer welcome than they

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might want."

The small survey ship had taken off within twenty minutes of Tastnest's death. Two hours after that, it docked with the mother ship in Earth orbit.

Salo had requested, and been granted, a formal audience with the Cayalla. Brasnet had gone directly to the communal room of his group to prepare himself for the inevitable. The summons was not long in coming.

One of the Cayalla's attendants appeared in the corridor outside the door. "Brasnet!"

"I hear," Brasnet responded wearily, gently stroking the soft, supple skin of his group's moleana.

"The Cayalla wishes your presence."

"I come."

The corridors seemed to have doubled in length, Brasnet tasted shame and bitterness. There had been no reasonable alternatives.

The Cayalla's quarters were no better or worse than the ones provided for Brasnet's breeding group, but the fact that they belonged to the Cayalla was sufficient to give them an aura of power.

Salo sat to the Cayalla's left and showed visible signs of grief. The Cayalla stood with foreleg unfolded over Salo's head in a protective gesture. "Brasnet, do you wish to embellish Salo's account of what happened?" the Cayalla asked softly.

Knowing that Salo would have been in rapport with the Cayalla, and that the report thus given would have been literal and accurate, Brasnet answered, "No."

"You have placed Salo's group in a position of alolo."

"I am aware. It was a difficult decision."

"You were attempting to prevent alolo *on other groups?" the Cayalla persisted.*

"Yes."

"Your own included?"

"Yes."

The Cayalla stood motionless for nearly fifteen minutes before speaking again. "I have decided. Your proper course of action would have been to risk alolo *on your own group rather than allow Salo to suffer in this way. There are precedents for transferral of* alolo, *do you wish to review them?"*

"Not at this time. I will study them later. My mind is clouded now."

"You shall return. You shall attempt to retrieve Tastnest's remains so that the rituals may be completed. Should you fail, your group will assume Salo's group's alolo."

"Aneroi suggested the possibility of triangulating Tastnest's death-cry," Brasnet offered. "I have no better thought, myself."

"Quenitoly."

On this signal that the interview with the Cayalla was over, Brasnet withdrew. Cursed be the day that lust for glory should lure him into leading another scientific mission to a planetary surface. This one time had been more than enough.

An hour past sundown, sudden scraping noises on the rough plank steps leading up to the porch brought

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Jasper and Emma to their feet, each reaching for a gun. Emma held a kerosene lantern in one hand and the cocked rifle in the other. "Hold it, Jasper, it's one of the dogs."

Rear legs dragging, the dog clawed its way up onto the porch. Once there, it rolled over onto one side, flanks heaving.

Jasper pushed past his wife and pushed the screen door open with his forearm. The shotgun was in his other hand. "Sam? What's wrong with you, boy?" Slowly and with great difficulty, he got down on his knees next to the dog. "Sam?"

The dog vomited, then resumed panting heavily.

"God, that smells bad," Jasper said. "What's this dog been eating?"

Sam's rear leg began twitching uncontrollably. Within seconds, the fit took his entire body. When it stopped, the dog was no longer breathing. Jasper placed his hand on the dog's head gently. "Sam?"

"Jasper, there's nothing you can do for him, come back inside."

"He's . . . "

"He's gone, Jasper. Come inside."

"But, I can't just leave him here."

"You're going to have to. It's not safe to be out there." Indeed, the death of the dog had done more to convince her that something was amiss than all of her husband's wild talk of Nazis.

Nodding slowly, Jasper used the shotgun to push himself to his feet. "I'm coming."

"Do you think we should turn out the light in here?" Emma asked, gesturing at the single naked bulb in the center of the ceiling. "All we're doing is making it easier for them to see us."

Jasper stood looking down at the dead dog for a moment. "Yeah, turn off the light. Give me the lantern and I'll put it out here. That way it'll light the yard."

"What if they shoot it out?"

He turned and looked at her through the screen. "Then we'll know they're coming, won't we?"

The blunt nose of the survey ship came over the eastern ridge with only a soft hissing. The ground below appeared to fall away as it sloped down to the pond.

Brasnet pulled back on the finger loop that controlled forward travel and the ship hovered. "Unless you were deceived by echoes, Tastnest must have been somewhere on the far side of that water."

Aneroi consulted his memory of the death-cry. "Yes."

Brasnet flipped the finger loop and the craft glided forward. "And you heard no squeal from Tastnest's moleana*?"*

"Nothing."

"Perhaps it is still alive."

"You did not think it likely earlier," Aneroi pointed out.

"The Cayalla clarified my thinking for me," Brasnet noted wryly.

There were only the two of them. More would have been an unnecessary risk. With Salo incapacitated by grief, one of the other two had had to come in order to guide Brasnet to the spot where Tastnest had fallen. Aneroi had volunteered. Either glory or alolo *would result for the one who*

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served as guide. Aneroi had thought the risk of comparatively minor alolo worth the potential glory.

"There," Aneroi said, pointing at an area across the pond. "My memory of Tastnest's death-cry corresponds with—Tastnest!" The water was not deep enough to hide the corpse. The ship dropped in a gliding arc, until it was skimming barely a hand's breadth above the water, the combined glare of its three forward searchlights throwing bright reflections into the weeds at the water's edge.

Brasnet delicately twitched the finger loop and the craft slowed, coming to a halt barely a yard from Tastnest's body. He stared at the thick weeds. "One hopes that the predators that brought Tastnest to death do not hunt by night. If intelligent, they may be using Tastnest as bait."

Aneroi heard the fear. It corresponded closely with Brasnet's mental profile. At best an uninspired follower of commands, Brasnet could be counted upon to do the minimum required in any situation, no more. "I will bring Tastnest's remains aboard."

"No. This is my task."

"I have volunteered," Aneroi noted.

Only Brasnet's breathing could be heard for the next few moments. "Hold the ship steady. I will do this."

Brasnet stood at the portal looking down at the water. Was the pond large enough to support an aquatic predator? Before such thoughts could congeal into paralyzing fear, he jumped into the water. Tastnest's body bobbed gently as the waves lapped past. Cool mud sucked at Brasnet's hind feet.

Picking up Tastnest, Brasnet cast one fearful glance at the shoreline, now only a body-length away, then turned toward the ship. Pushing the limp body through the hatch turned out to be more difficult than anticipated. Finally, Brasnet was able to heave through into the safety of the ship's cabin. Only after the hatch was closed did fears of attack subside.

"Tastnest's moleana," Aneroi prompted. "We should try to find it."

"You heard nothing. We have no idea where to look."

"True, but we must try."

"Tastnest's moleana could be anywhere."

"Exactly. That is why we must try. To abandon a moleana deprived of its master, to such a lonely death would be raas."

Brasnet's first impulse was to say that there was no chance of finding the little creature, but the mental image of the Cayalla brooding over Salo's alolo overrode caution. "You propose?"

"Circle the area at low altitude. Broadcast a copy of Tastnest's mating call and listen."

Brasnet blinked all three eyes simultaneously. "Elegant. But if the moleana does not respond?"

Aneroi's forelimb rotated and pushed forward in a corkscrew motion—equivocation. "We can but try."

Brasnet flicked the finger loop and the craft rose, leaving the pond rippling with the side-effects of the drive system. Once slightly above treetop level, a recording of Tastnest's hoot-

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ing love-call echoed through the trees. The ship slowly spiraled outward from the pond, listening.

Jasper Hudson started, then winced. His eyes probed through the screen door, through the circular pool of light spilling from the lantern on the railing, and into the darkness beyond. "What was *that?*"

"Sounded like an owl."

Jasper shook his head. "Too low. And it lasted too long."

Emma frowned. "Well, your Nazis ain't got no reason to make such a noise."

"They ain't *my* Krauts!" He squinted into the humid night air surrounding the house. "Wish Danny would come back. I might could tell something by watching him listen to that sound. The dog'd know whether it was Nazis or not."

"He might be back. Just might not have come 'round to the door."

Jasper turned and looked at her, then nodded, as though to himself. "Could be. I'm going out and see if I can find him. He might be back behind the shed again. That's where he was this afternoon."

"What if he isn't there?"

He shrugged, then winced. "Then he's not there. But if he is, then I'm bringing him back. Anything will help if those Nazis attack."

Emma looked out the door at the body of the other dog. "If he ain't there, don't you go lookin' around for him. You come straight back here."

"But he might—"

"He might be alive, he might be dead. So far *you're* alive, 'cept as you've hurt yourself. You just come right straight back here."

Grumbling, Jasper pushed himself up out of the chair, put on his glasses and stared out through the screen to assure himself that there wasn't anyone visible, then pushed out onto the porch. He stood looking down at the dead dog at his feet for a moment. "Emma, I think I'll at least get Sam off the porch. I don't like looking at him like this."

She started to tell him not to, but she, too, was disturbed by the sight. "Well, let me help you, at least. You can't lift him with your side hurt."

"Sure I can."

"No, you can't," she said. She was already beside him. "You just pick up the lantern. I'll get Sam."

The hooting call sounded again, seemingly farther away.

"That ain't no normal sound," Jasper insisted, as though he expected her to argue the point.

"Whatever it is, it's moving away. Let's get this done and get back in the house." She bent and picked up the dog, having trouble with the limp form.

Jasper watched her. "You sure you don't want me to carry him?" There was a slight catch in his voice.

She shook her head. "Let's get it over with."

Together, they went down the steps, with Jasper slowly leading the way. The shed was to the side of the house, about twenty feet away.

"Danny-boy," Jasper called quietly. "Danny, come here."

There was no response. Jasper reached the shed and passed around

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the back side. He came back.

"No sign of him."

Emma said, "What do you want to do with Sam?"

Jasper sighed. "We ought to bury him. It seems indecent to leave him somewhere."

"Let's leave the burying 'till daylight, Jasper. We'd best get back inside."

He nodded reluctantly. Hesitantly, he reached out and ran his fingers through the dog's fur. "He was a good 'un."

Emma bent and gently deposited the dog on the ground next to the shed. "He'll be all right here for the time being. Tomorrow we'll get the shovel and do it right."

As they came back around the corner of the shed, they could see light from within the woods, not far from the edge of the field.

Jasper frowned. The round wash of light looked as though it were being thrown by a very, very bright lantern, but he couldn't see the lantern itself. Then, like an optical illusion snapping as the eye adjusts, he realized that the light was coming from *above*. "Emma! There's something over the trees!"

"I see it," she gasped, already hurrying forward. "Let's get inside."

Jasper stood and stared at the light, anger suffusing his face. "That's them Nazis, Emma. There ain't any blimps around here."

"Blimps? What makes you think it's a blimp," she called back from the wall of the house, where she was using the corner for cover as she edged towards the front of the house.

"You don't hear anything, do ya? Gotta be a blimp. That's the only thing that can hang in the air like that and not make any noise."

"Jasper, be sensible! What would a blimp be doing in the woods?"

"I don't know, but it's those Nazis. Has to be. Gimme the gun. I'm going down there."

She reached the corner and peeked around, judging the course she'd have to take to reach the front door. "Jasper, you're a fool! There isn't a thing within miles of us that the Germans could be interested in. Not a thing. The nearest town is Dysartsville, and that ain't diddly to your Nazis."

"Well, if you ain't afraid of 'em, why are you hiding from 'em?" he demanded.

"I'm not in the mood to take chances," she said, and darted around the edge of the house.

"Is that, or is that not, Tastnest's moleana*?" Brasnet crowed, tapping the imaging screen with the cone-shaped nail at the end of one finger. "Now we may fulfill our mission properly."*

"That the computer was able to identify such a small creature through as much foliage as covers the area is indeed fortunate." Aneroi said, somewhat disturbed by Brasnet taking credit for the success of his idea.

"True. Had this plant not been dead, it, too, would have been covered with foliage, and we would not have found the moleana*."*

"There appears to be some sort of indigenous creature lying near the

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moleana. *Do you suppose that it killed the* moleana, *or that it is a scavenger that simply happened upon the body?"*

"Does it matter?"

"If it is a predator, and if it has a den near here, there might be more of them."

"It is dead," Brasnet said.

"So is the moleana," *Aneroi replied pointedly.*

Jasper was having great difficulty picking his way through the trees. His glasses had been whisked from his face by a branch; there had been no chance of finding them in the dark without a lantern, which was the last thing he could risk.

Ahead, roughly in the center of the illuminated area, was a dead red oak, the victim of a bolt of lightning the previous summer. Its leaves had fallen, leaving a hole in the forest canopy where the light could come through. It stood starkly outlined in the blue-white glare from above, the bare limbs casting motionless shadows on the ground. There was a dead bird at the foot of the tree, possibly a hawk. Maybe even the one he had seen that afternoon. A smallish dark body lay nearby.

As Jasper worked his way closer, he could hear a faint hissing coming from the craft above; that was all. Somehow, that sound made him uneasy. Briefly he entertained the notion of shooting at the ship. Maybe if he could tear a big enough hole in it, the gas would leak out and it would crash.

He paused behind a large beech, pressing his back flat against the smooth bark. He held the barrel of the gun down along his leg so that it would not cast a shadow of its own. He thought it unlikely that anyone in the ship could see his hiding place easily, but he was not going to take any chances. Slowly, he pushed his head around the bole of the tree, looking upwards at the ship.

The light was too bright; it blinded him, bringing tears to his eyes. Involuntarily, his eyelids squeezed shut. If he could not see, he could not shoot. To shoot at the light would be useless. Surely, it would be mounted on the gondola, which would be the part that was most likely to be able to resist his fire.

No, he needed to be able to see the body. As it was, he could not even tell whether it extended from east to west or north to south, or in any other direction. He wished for the Moon, but it would not rise for several hours.

Cautious steps sounded behind him. His heart leaped into his throat. He spun, trying to line up his gun with the source of the sound, but the stock slammed against the trunk with a loud *thwack.*

"It's only me, Jasper," Emma whispered.

"Woman, what in *hell* are you doing here?"

"You're not much use with your side hurt," she said simply.

"I won't be much use if you scare me to death, either!"

She squinted upwards. "Wonder what they think they're going to find out here in the woods."

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"How the devil should I know?" Jasper demanded. "Maybe they're looking for a place to land."

"They'd do better to go down to the road," she observed.

Jasper's head snapped around. "*Shhh!* I think I heard something."

She listened, but heard nothing. "What are you going to do?"

"Shoot them."

"Jasper Hudson, you're a fool! How many shells are you carrying? Just three? How many men are in that thing?"

A loud click, metal on metal, sounded from over their heads. They both peered around the trunk of the tree, shading their eyes to lessen the glare. After a few seconds they noticed a shadow. Something was coming down.

Brasnet watched the bare limbs of the tree slide upwards as the ship's volnoost *lowered him to the ground. Tastnest's* moleana *lay a bit to one side of the tree; the other creature a little beyond.*

It was the other creature that held Brasnet's interest—and fear. It was dark in color. Wide, flat, thin limbs were spread in disarray. Two other limbs tapered to smaller versions of the nails on the ends of his own fingers.

It seemed likely that the dark creature had fallen out of the tree. Whether it had flown to the tree or had climbed it was open to interpretation. Either way, it must have tried to eat the moleana.

There were powerful chemical differences between the indigenous life forms and those from Brasnet's planet. That had been discovered by the preliminary survey crew as they were trying to determine whether it would be possible to live off of the resources of this planet. The answer was an emphatic no. For either side to partake of the other would bring on hideous death, marked by convulsions.

The moleana *seemed intact, which was good. To bring back even a small part would be sufficient for the rituals, but there was emotional comfort to be derived from having the complete body.*

Brasnet stopped the volnoost *when it was half a body length above the ground. It would be foolhardy to set foot on the ground when there might be other predators about. Potential hiding places abounded. Shadows were everywhere. There were . . .*

The concussion was simultaneous with the perception of impact from behind.

Aneroi, from above, saw everything with perfect clarity. One of the bipedal creatures, tentatively classified as a sentient, appeared from behind a tree and pointed something at Brasnet. Immediately, there was a flat loud blast and Brasnet was falling from the volnoost, *one leg completely severed just above the mid-joint.*

Suddenly thrust into a command situation at a time of crisis, Aneroi discovered that it is easier to make a decision when the weight of possible consequences are not falling immediately upon one's own shoulders.

Precious moments were lost as alternatives were considered. Mean-

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while, Brasnet lay on the ground below, gravely wounded, probably dying. The pressure made it even harder to come to a decision. The knowledge that each passing moment was being irretrievably lost was an ironic deadly distraction.

Involuntarily, Aneroi glanced at Tastnest's body, sprawled in an ungainly heap on the deck. Was it worth Brasnet's life to have gone after the moleana*?*

Such second guessing was pointless now. The decision had been made. Now Brasnet lay on the ground below and the question became whether it was worth Aneroi's life to try to rescue Brasnet.

Jasper, cursing, was lifting the gun to his shoulder for a second shot. If his side hadn't twinged at the wrong moment, he'd have killed the man, instead of merely blowing his leg off.

Just as he pulled the trigger, a dark shape landed on the barrel and slapped it downwards. The shot, still in a tight pattern so close to the muzzle, plowed a dark furrow in the earth five feet in front of him.

His head snapped up.

"Jasper, you *idiot!*" his wife bawled right into his ear. "Don't you *dare* shoot at him!"

Anger surged within him. Had she taken leave of her senses? There were Nazis here, not more than a hundred yards from their house, and she was telling him *not* to shoot?

Before he could formulate a reply, she pointed. "That's not a man, you fool! Look at his hand! Is that a human hand? What have you done?"

"He's a Nazi!" Jasper whispered angrily, finally finding his voice. "Look at his shirt!"

"Look at his *hand*, you idiot! That's not even a human being! How can he be a Nazi if he's not even a person?" She snatched the gun from his grasp. "Give me that before you do any more harm," she hissed.

"Emma, wait! They'll . . . "

Stalking forward, heedless of personal danger, she reached the pool of light surrounding the fallen stranger. Squinting upwards, she held the gun aloft so that it would be easily visible, then placed it on the ground. She knelt next to the inert form. Shaking with reaction, she looked at the dark, almost black, blood flowing freely from the stump where its leg had been only moments before. She knew no first aid; it was obvious that the creature would die without help.

She did what she would have done with a human gunshot victim. She lifted the head into her lap. Perhaps contact with another would serve to comfort the creature as it died.

Three violet eyes stared back at her sightlessly. Shock kept them from focusing. They were mounted comparatively higher in the head than on a human's, the central eye being slightly lower than the other two.

There was an opening below the eyes, but whether it was mouth or nose, she could not guess. Perhaps both. There was no hair, but the skin on the head was darker on top than on bottom, like the trout that Jasper brought in sometimes. From a distance it might look like hair, but up close there was no mistaking the

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smooth scalp.

The creature's breathing was labored. Each gasp whistled slightly. There were no lips; the skin was hardened and calloused.

She raised her head and called to her husband, still in the shadows. "Jasper, what have you done?"

His reply was low and hard to hear, but she made out the word Nazi.

There was no point in replying to that. She looked own at the cream-colored tunic with the large blue swastika on it. Surely no Nazi would wear such a large symbol on his chest. Nor had she ever heard that they wore light-colored uniforms; all the uniforms she had heard of were gray, although everything reduced to shades of gray in the newsreels.

What had the world come to that a mere geometry of lines could cause a man to shoot an innocent creature?

She sighed, then reached out and gently touched the creature's forehead. It was hot to the touch—much hotter than a human's forehead should be.

A jerky movement in her peripheral vision brought her eyes back to the chest. The creature had brought one hand up and was grasping at its chest.

Emma had coped with the alien face with a stout heart, but the close-up sight of the hand nearly unnerved her. One strongly muscled central finger nearly ten inches long was flanked on each side by a much shorter finger. The skin was dark and taut, but the terrifying thing was the claw on the middle finger. It was deeply grooved and hooked, and gleamed in the light from above.

Swallowing hard, she forced herself to look back at the face. There was no expression there that she could read.

She looked up, but could not see anything except the light. She made beckoning motions with her free hand, hoping that someone might be watching. Perhaps there was a doctor on board.

Agonies of indecision!

One of the bipedal sentient beings had placed the weapon on the ground. It was in clear sight.

Could that be taken as a peaceful gesture?

Then why had they ambushed Brasnet?

Could it be a trap?

The other one, the one who had been holding the weapon when Brasnet was hurt, remained in the shadows. Could there be another weapon?

The one who had placed the weapon out in the open now crouched next to Brasnet. Its actions were inscrutable. It was examining Brasnet, but made no attempt to staunch the flow of blood.

It turned upwards and looked up at him, then gestured with a free limb.

But what did the gesture mean?

The nearest equivalent body language expressed cautious approval, but that didn't make sense—did it?

No, it must mean something else. Unfortunately, the bipedal creatures had not been studied. An entirely different expedition would be mounted later for that one purpose. The current expedition was here only to

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study flora. In retrospect, it was clearly a mistake, for now there were no referents upon which to base an interpretation of the gesture.

As far as Aneroi was concerned, the meaning might as well be completely random, assuming that it meant anything at all. It could even be reflexive. Perhaps a prelude to feeding.

Five creatures were arrayed on the ground below. Two live, two dead, and one dying.

What would the Cayalla want him to do?

Aneroi pressed a nail into the hole which retracted the volnoost.

A subtle change in the light caused Emma to look up. The metal disk was gone.

She shook her head and looked back down at the face in her lap. They were leaving this poor creature here to die.

If only Jasper hadn't been so quick to shoot. She had seen that he wasn't wearing his glasses. Perhaps if he had had them on, he would have seen this wasn't a man. True, it did look somewhat like a person, but that wasn't—another change in the illumination brought her head back up.

The disk was descending. On it was another creature.

Her breathing came more quickly as she realized her danger. This creature was bound to be angry. Had to be.

Before she could decide whether to run, the disk reached the ground. The creature made no move; it only looked at her.

She pointed at the bleeding stump. "He needs help. Are you a doctor?"

Behind the creature, she saw movement. "Jasper, don't you try anything . . . hear?"

"I ain't going to touch him," came the surly response.

At Jasper's voice, the creature on the disk spun to watch him as he walked slowly out of the woods. As he skirted the perimeter of the pool of light, the alien pivoted slowly, always facing him directly. At the point where Jasper came closest to the gun, the three eyes flickered as though gauging whether her husband would try to grab it.

"I ain't gonna get the gun. OK? I don't want any trouble," Jasper said, palms held out. "I'm just going over there to where my wife is. All right?"

Moments later, he was beside her. "By damn, that critter's got three eyes," he whispered.

"I told you he wasn't a Nazi," Emma said.

"He's dying."

"I think so. I don't know anything to do to help him, either."

She looked back to the creature on the disk just as it stepped to the ground. The creature in her lap twitched. She looked down to see the eyes closing. She looked back up. "Hurry. He's dying."

The other creature moved no faster. When it reached her it did an astounding thing, its arms unfolded and it fell forward onto all fours like an animal.

She screamed, suddenly face to face with the second alien.

It blinked at her very slowly, almost a slow caricature of a three-eyed wink, then looked down at its com-

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rade. It made a soft, raspy noise, but received no response.

It looked back up at her again. Its weight shifted back onto its rear legs and it slid its front legs under the body. With an awkward lurch, it stood on its hind legs, lifting the burden with great difficulty. Then, turning, it walked back to the disk and placed the body on it. It then retrieved the small creature lying next to the hawk's body.

Still carrying the smaller body, it stood on the disk and rose slowly into the glare.

As the sky grew gray with the approaching dawn, Jasper fell into an uneasy sleep. Emma sat near the screen door watching the night retreat. The gun was next to her hand, but she didn't think she'd need it—she'd watched the ship depart.

As the sky got lighter, she could see the craggy uppermost limbs of the dead tree outlined against the sky. It looked normal this morning, just like it had looked the morning before, just like any other dead tree. There was nothing about it to suggest that there had been some sort of blimp or airplane hovering over it last night.

She stared at the tree and tried to imagine it. Such a thing had never been seen this far back in the woods.

Next to her, Jasper groaned slightly in his sleep. As soon as it was fully light, she'd go for the doctor.

"It was debated," the Cayalla said, "whether to study the sentient beings first. I argued for starting with the plants. I reasoned that once we established communication with the sentient creatures of this planet, they would monopolize our attention and we would never complete a thorough study of the flora."

"We learned much," Aneroi said, by way of consolation.

The Cayalla gestured at the three bodies arrayed on the deck. "And we lost much." Minutes passed. "And all because I wished to earn glory for our ship and crew. Instead, we earned alolo."

"There was no reason to think that they would harm us without provocation."

"How do we know what constitutes provocation?" the Cayalla cried in frustration. "We know nothing of them. We may have crossed territorial boundaries. We may have interfered with their food gathering. Perhaps they routinely fear any creature that moves by night. The point is that we don't know, and so we cannot blame them."

"If only we knew what provoked them."

"Two eand *and a* moleana *are dead. By the laws which bind us, we may have no further contact with a species once* eand *have died. We shall never find out why they died," said the Cayalla, reaching up to finger the angular cross on his tunic, the figure representing the numeral eight—the fleet number of their vessel.* ■

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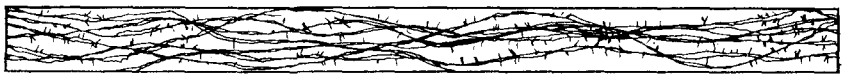

Probability Zero

PRISONER'S DILEMMA

Jeffrey G. Liss

At least some things never change, the President sighed.

The staid furnishings of the Oval Office comforted him. They murmured continuity and stability, and the solvability of all problems. They probably were unchanged since John Kennedy's days. Before that—before Jackie finished her redecoration —who knew?

He sighed again, and returned his eyes to his visitor.

"Thanks for coming," he said to Barbara Allison, the retired but legendary Secretary of Labor from many administrations ago. "You're still our best expert on group behavior in times of social change. Perhaps if I think out loud, you might have some insight which will help explain this terrible crime wave.

"I just don't understand it. More and more of our best people, our pillars of society, are turning criminal. Bankers. Lawyers. Doctors. Executives. Engineers. Scientists. Teachers. Poets. Yes, especially poets."

"I take it," Barbara said, "that you can get no explanation from them?"

"Correct. When they are arrested, they just plead guilty. They won't answer any questions as to why. I've looked at dozens of holovids. They're like a bunch of Mona Lisas. They just stare placidly with the same damnably silly smile—as if they know something that we don't.

"One man—an engineer who burned down his company's warehouse one night, a month after retirement, was heard to mumble, 'I hope I didn't wait too long.' But that may not have general application."

"Have the computers revealed any statistical correlations among them? Age? Sex?"

"They are equally men and women. They are of all ages, but increasingly seem near or at retirement age, or at least their children are grown."

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"Are they all well off financially?" Barbara asked.

"Not particularly, but most of them seem to have been successful in their jobs, whatever they were.

"We have charted crime patterns by education and IQ, and there is a definite correlation in both cases. The brighter the population group, the faster crimes are increasing. In fact, with the exception of that group, our new penal policy seems to have reduced the major crime rate considerably over the past ten years."

"Hmmm," Barbara mused. "Is there any pattern to the types of crimes these people are committing?"

"Not really. Industrial sabotage. Embezzlement. Computer crimes. Burglaries—mostly of government buildings. Some arson. A lot of tax fraud. The funny thing is, they don't seem to try hard to hide their crimes."

Barbara leaned forward. "Now that's interesting. You did not mention armed robbery, assault or murder. No crimes against individuals, but crimes against society as a whole—the ones we now punish the most severely. In all the crimes you mentioned, no one gets physically hurt. Tell me about the arsons. Was anyone ever hurt there?"

"No. Wait. I saw one case in which a derelict had been sleeping in an abandoned building that had been torched. I remember, the guy who did it was sobbing uncontrollably—a fifth grade teacher.

"You may be on to something," the President continued. "It's like they want to commit a crime that doesn't hurt people. But that's crazy. What kind of criminal is that?"

"What are you doing with these people?" Barbara asked.

"What can we do? We just keep building more and more housing in the Heinlein Prison Colony on the Moon, and ship the prisoners there as fast as we can. A few guards and a little vacuum isolate the violent ones easily enough, and the rest don't need cells. They just get hard labor—monitoring the automated lunar mines and solar power arrays, and maintaining equipment and hydroponic farms for the Asimov, Bova and Clarke Lunar Research Stations. And, increasingly, building new housing for the next batch of felons. Plus they have to run the prison power and air plants —they have to divide up those chores themselves—and do their own housekeeping. We don't send people to help them.

"Transporting prisoners has, in fact, occupied 75 percent of our entire space transportation capacity. We can hardly service the Lunar Research Stations—which makes me thankful that we never tried to build large scale colonies there.

"I just don't understand it. Exile from Earth has really deterred most would-be criminals. Yet those who should know best are precisely the ones committing crimes these days.

"It's just crazy. It's like they want to be punished. Help me, Barbara. Help me figure this out."

He looked at her, distraught, plaintive, hoping for some answer. ■

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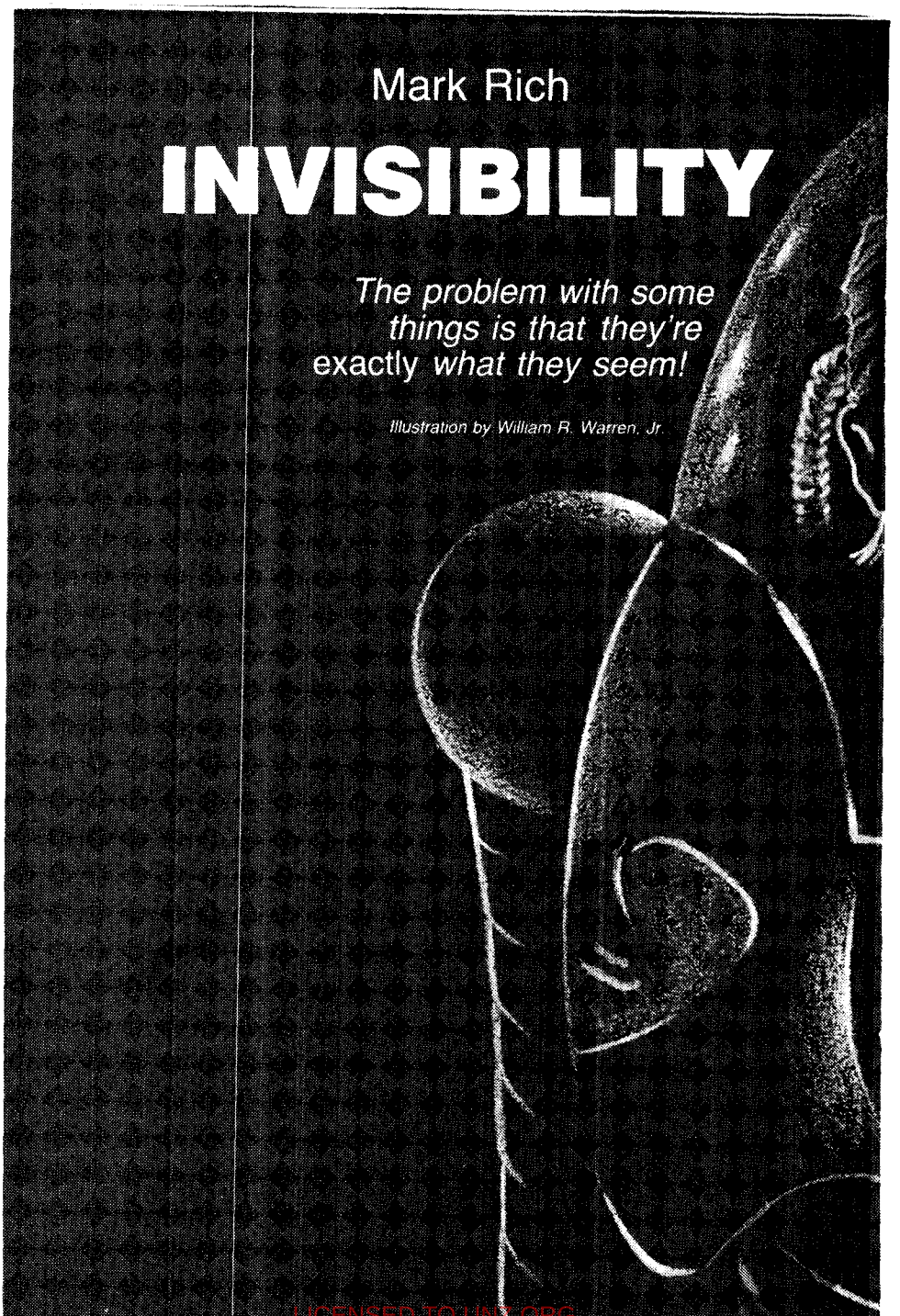
Mark Rich

INVISIBILITY

The problem with some things is that they're exactly *what they seem!*

Illustration by William R. Warren, Jr.



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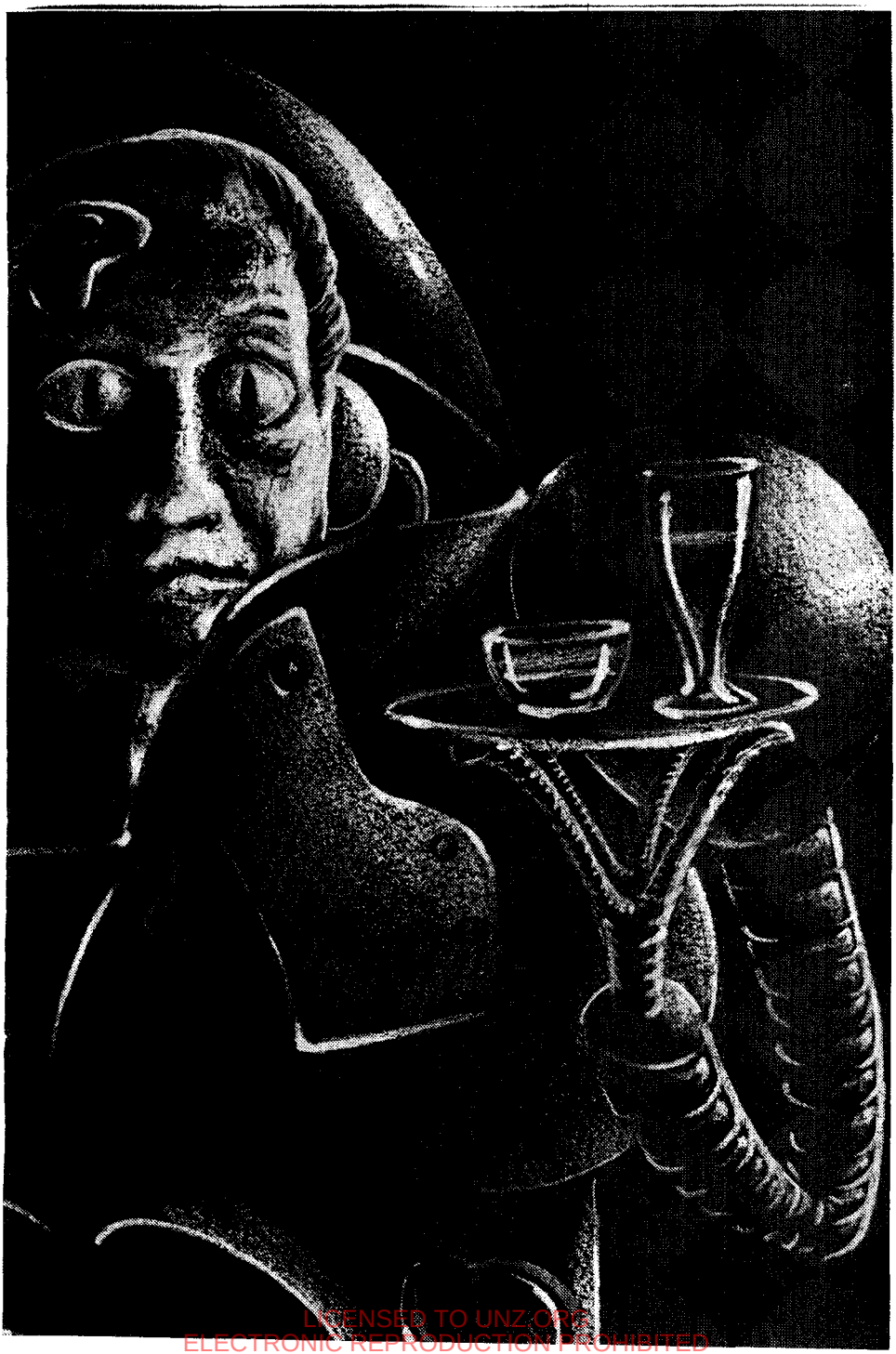

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The afternoon at the Cafe Henri, in the Hotel Humaine, might have passed quickly had Metrio Smiti not brought in the nervous young man for drinks.

On any particular afternoon in Movissa, chief city of the planet Iaca, any number of humans might be lounging at the tables of the Cafe Henri, watching the dramatic cloud formations that typified the view over the ocean. Iaca, one of a fleet of worlds that jumped between stars in search of other beings, had its share of both humans and non-humans. In this cafe, however, being auxiliary to an establishment fitted for the comfort of humans rather than non-humans, non-Terrene folk tended not to make an appearance. The fabulous sky colored by the protracted setting of its artificial sun, after all, suffered itself to be viewed from other restaurants, bars, and cafes on the planet's single continent. Many of those establishments, moreover, served drinks more palatable to non-Terrene taste buds than those served by Jeeger, the quasi-automated servitor of the Henri. As a result, the regulars here reflected an undeniable human persuasion.

Metrio Smiti, a red-haired artist now in his eighties, sat down at a table near the two other regulars already relaxing with their drinks.

"You've brought someone new, Metrio," said Hazel Monpelie, a semi-retired linguist who counterpoised her noble profile and bearing with flamboyant clothing. "Getting tired of our company?"

"It's a ploy," said the other, the planetary ecologist named Rod Dangorn. Though older than either Smiti or Monpelie, his long, shiny black hair, pulled back now into a ponytail, gave him a youthful appearance. "A smoke screen. Metrio brings a guest thinking we'll forget to plague him about the artwork he isn't producing."

"I've been drawing and producing new pictures, as always," said Metrio with good humor.

"Probably with that antiquated pen and ink," Dangorn said, his dark features crinkling into a smile. "How can one do new art with old methods?"

"I believe in simple methods. If you make things too complicated, you can't even *see* what's new. One of the things I like about old-fashioned pen and ink is that it forces me to think about the basics. I need to look anew each time at the idea of the dot and line, and of white and black space. If I relied on all the modern techniques, half the thinking would be done for me by a computer—and as a result, I wouldn't have to go back over my assumptions and reevaluate them."

"But that wastes time," said Dangorn. "You could be speeding on your way to great works, and maybe even—dare we say it?—fame and *fortune*!"

"Who needs it?" said Metrio. "Give me my simple ways, and leave me my simple life." He lifted an invisible glass in a toast, smiling with satisfaction.

"Simple methods are always admirable," said Jeeger, the servitor, appearing beside them. "Drinks?"

Metrio asked for his usual chianti,

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while the nervous young man with him requested tea.

"A man after my own heart," Dangorn said to Metrio's guest, holding up his own large mug, redolent of jasmine. "How can one use one's head if it's clouded by liquor?"

"I say it's a hell of an order," said Hazel loudly. "Looks like the poor man has the nerves, and could use a stiff drink. Why not a whiskey?"

The nervous young man held up his hands apologetically and shook his head. "Stomach can't take it."

Hazel laughed. "My stomach can't handle tea. Eats out the innards, I say."

"I'm sorry," said Metrio. "I haven't introduced you to each other. This is Ian Bekker, a member of the current reception team." He then introduced his friends to Bekker.

"The current reception team, really?" said Hazel. "I've heard rumors that we've just contacted a dilly of a new species, that we haven't figured out yet."

"Yes," said Bekker, steadying a bit as he took his tea mug from Jeeger. He smelled its aroma appreciatively before setting it on the table. "Please forgive me my shakes. Nervous exhaustion. I've been working constantly at it, and have to go back up to Orbital Point to try to crack the difficulties of these new ones. You're right. They're a puzzle."

"I got talking to Bekker here in the front lounge, and was fascinated," said Metrio. "Don't feel bad about repeating things for me, Ian. Go ahead and tell them about these new people we've run into; if we may call them people, that is."

"Yes. That's always safe, calling a new race 'people'—because that's always the assumption. They couldn't be there for us to contact if they didn't have some kind of intelligence similar in some way to ours. But we're having the damnedest time getting through to these."

"Why's that?" said Dangorn.

"They're invisible."

"Invisible? That's impossible."

"Apparently not. Moreover, to make things stranger, they appear to be humanoid. Invisible, but humanlike of general form."

"You don't expect us to believe that, do you?" said Dangorn. "How are you sure they aren't somehow altering their appearance in imitation of our form? I'm always suspicious of that, when we first meet a humanoid people." His brows furrowed in thought. "But now wait a second, Bekker! If they're invisible, how do you know they're humanoid?"

A smile crossed the young man's thin face. "They—these people—apparently monitored some of our broadcasts. Human broadcasts in particular. Because they have appeared to us dressed in a popular human style." He looked down at himself and then held out his hands, as if to indicate the clothes he wore, a simple and serviceable combination of white jeans, light shirt, and thin jacket. "Male clothes on two of them, female clothes on the third. Absolutely typical clothing that you'd find on any human on Iaca. Utterly bizarre to see because the clothes stand there, on the other side of the transparent bar-

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rier that splits the reception chamber in half—and *you can't see their bodies.* It's almost frightening. A thing out of a nightmare. They stand in different poses, move their arms, mimic human gestures, and walk around —all in an effort to show how well they've absorbed a small spectrum of human behavior from whatever transmissions they've monitored before actually contacting us here." Bekker shivered.

"It's impossible for beings to be invisible," Dangorn said.

"And wouldn't they be blind, if they *could* be invisible?" said Hazel. "If light can't hit any part of them, they can't have anything resembling our eye. They couldn't have anything that would pick up light and transmit visual images to the brain—since all the light goes *through.*"

"That's right," Dangorn said. "If they're humanoid, you should have a rough idea where the eyes are, and could find the small, visible spots of the retinas. The macula and fovea—two regions of the retina which should, after all, have an equivalent in these people—should be visible. If they weren't opaque to light then they wouldn't do what they're supposed to, and these people would be blind."

"We've thought of that," Bekker said. "There's no sign of anything like retinas visible."

Metrio leaned forward. "Have you checked on all light frequencies?"

"All of them," Bekker said, the nervousness apparent in his hands again as he set down his tea. "I tell you, it haunts me. I came down to the surface from Orbital Point, just to get away from the problem. But I haven't been able to sleep, because as soon as I shut my eyes I see them standing there—they're almost like *mockeries* of humanity! It's intolerable!"

"Calm down!" said Monpelie. Her usual loud style, however, conveyed no sense of calm. "We'll figure it out! Jeeger, another whiskey sour, if you would?"

"I still say it's impossible for a material being to be invisible," Rod Dangorn said.

"Then an immaterial being?" said Metrio.

"An immaterial being wearing clothes?" said Bekker.

"Maybe just to comfort us."

"Absurd, Metrio!" shouted Monpelie. "An immaterial being, if it wanted to reassure us by appearing in our image, would go ahead and *do* so, rather than playing games and appearing as an invisible body wearing clothes!"

"They might regard that as an immaterially fine point," Metrio said, his face trying to remain serious. "Besides, isn't the playing of games a mark of intelligence?"

Hazel ignored him. "Bekker, I just realized the stupidity of my earlier statement. Despite what Dangorn says, they *must* be able to see—for otherwise how would they have seen our images and imitated them? It's a paradox."

Bekker shrugged. "You begin to see how vexing this is. Our difficulty is that we can't set up communication. We've been trying to communicate with them, but without result.

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It's almost as if they don't care about communicating with us. And yet they *must* be intelligent beings who are curious about us, for they approached our Orbital Point, and followed the instructions—which of course are broadcast in every imaginable language and symbol system, in every conceivable way—for entering the reception center. So even if it doesn't seem like it, they *must* be trying to communicate with us. Their posturing must mean *something.*"

"They think it's part of our language, obviously," Hazel said. "They think the syntax is contained in movements. Just think of how confused they must be getting, seeing you react to their movements, without doing so in a logical manner!"

"That further confirms they must see extremely well," Metrio said. "If they think our syntax is visually oriented, then they must have found some way of having eyes, even if invisible."

"They must have low capabilities for hearing," said Hazel. "If they monitored a transmission well enough to accurately mimic the clothing we wear, then they could have monitored our speech as well. But you haven't said they speak Terranglish."

"They don't make a sound. And we've checked the various frequencies," he said, looking at Metrio.

"What if these people exist as networks of microscopic, floating cells?" said Dangorn. "You might get over the invisibility objection that way.

"But you would think that any spatially distributed network would be sensitive to changes in the surrounding air, and would be extremely attuned to vibrations," said Hazel.

"I'm afraid we considered that possibility, too," said Bekker. "We've increased magnification on any places we might expect to see any evidence of a microscopic network—around the places we have faces, and hands, and even around the clothing fabric—all to no avail. We've detected nothing. Somehow they have achieved total invisibility. And we can't figure out any way of getting through to them. We've even held messages on cards in our hands, without evoking any response."

Bekker looked around the table of faces. Metrio Smiti, Hazel Monpelie, and Rod Dangorn returned his look of dissatisfied puzzlement.

"I wish we could arrive at an answer for you, Ian," Metrio said. "We've spent countless afternoons here, entertaining ourselves with different puzzles. But with this—a true puzzle, one that matters—we've struck out."

"If I may make a suggestion," said a voice from just behind Bekker. The man almost jumped out of his seat in alarm.

Jeeger stood there, a plexicarb and steel melange of bodily parts reminiscent of humanity on the one hand, and more standard robots with wire casings and simple metal exteriors, on the other. Jeeger's body consisted of a vertical column a meter long, of a diameter approximately the width of the shoulders of a larger man such as Dangorn. Far from smooth or monochromatic, patches of different

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texture and color broke the surface of the cylinder, most of the hues hovering around rust and brown tones. The arms from the sides, covered with a flexible substance, extended to standard human lengths, and ended in hands bearing steely, thin fingers tipped with resilient pads. Similarly made legs hung below the body, since at the moment Jeeger utilized the option available to it of floating.

A broad, flexible shell of transparent plexicarb encased the head of Jeeger, which appeared more closely human than in most robots, marked most unusually by the well-defined, prominent nose. The copper eyes were large and luminous.

"I'm not used to robots making *suggestions*," Bekker said, settling himself again as Jeeger moved around to another side of the table.

"Jeeger's not exactly a robot," Metrio said.

"I *am* a robot, at least in part," said Jeeger. "But relevant to your discussion, may I make a suggestion?"

"Please do," said Bekker.

"Forgive me for listening in on your discussion. Most interesting. You seem to have considered all the possibilities except one."

"Being what?" said Dangorn.

"That you are having difficulty communicating with these new people because they, in turn, are trying to communicate with only a *part* of you."

"What?" said at least two voices at the table.

"Or to put it another way," Jeeger said, "the aliens are not invisible at all. They are fully visible. You *see* them."

The table sat silently for a moment.

"Moreover," said Jeeger, "it is *you* who are invisible to them, rather than vice versa."

"Speak sense, Jeeger! You're piling mysterious statement on mysterious statement!" Hazel Monpelie said. "First off, we can't be invisible to them. They *must* see us, if they can imitate our clothing so exactly!"

"I can attest to that exactness," Bekker said.

"Explain yourself," Metrio said quietly to the servitor.

"From my point of view, it's obvious," Jeeger said, his voice low and pleasant. "But, then, my vantage point isn't the same one as yours. So forgive me if I preface my explanation with *some observations to help you see* my point of view.

"When this young man started speaking, it occurred to me that his reaction sounded very familiar. As I listened, I realized that Mr. Bekker was expressing the same, frustrating feeling that I've experienced—and that I know other robots experience—of being ignored unnecessarily. It's in the robot's lot to have people of any species bypass them simply because they don't see *machines* as being of use in many situations—for instance, for providing company. Or suggestions. Often, when humans are seeking help, they will look for another human to provide that help, even if a robot fully capable of providing that help is nearby. It's less a matter of chauvinism than of being conditioned from childhood to turn to other humans for help. Robots are seen to have separate agendas, of be-

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ing oriented around a task or a service, and of being inflexibly tied to their duties—even despite the efforts of human cyberneticians to make robots as flexible as possible."

"But you just said you aren't entirely a robot," Bekker said.

"Nevertheless people perceive me as a robot, and so I am quite familiar with how robots are treated."

"Go on," said Dangorn. "You've made an interesting point, but I'm not sure I see how it fits into this situation."

"Before I show how it fits in, let me make one other observation about the place of robots in intelligent biological communities. Once robots are introduced into a community of intelligent beings, a relationship develops in which the biological and cybernetic beings benefit reciprocally. From the beginning, robots function as symbiotic organisms. They are entirely reliant upon their host species, which is always a biologic species, Terrene or otherwise.

"This isn't to say robots can't exist without biological beings nearby. They can—and do—undertake dangerous space missions without any biological beings along, for instance. Because they're one half of a symbiotic relationship, however, they still operate within the *context* of symbiosis, since biological beings are undoubtedly involved in some aspect of the space mission; the partnership itself is simply invisible to anyone who happens to observe a robot operating on its own."

"But we don't even see *half* of a symbiotic partnership," said Bekker. "We don't see anything."

"Yes, you do," said Jeeger. "You *do* see *something*."

"The *clothes?*" said Bekker. "So you're suggesting that these *clothes* we see are one-half of a symbiotic pair?"

"Yes," said Jeeger. "In the example I just gave you, the biological half of the biologic/cybernetic symbiosis is physically left behind, because the cybernetic half can more efficiently complete some missions solo, since spacecraft can be made smaller, lighter, and faster if no humans are on board."

"But you aren't saying these clothes are robots, are you?" said Metrio.

"Not at all. The symbiosis between cybernetic and biologic beings seemed the best way to present part of the picture. Now imagine a potential symbiosis for the beings you have just contacted. The fact that they can perfectly mimic your clothes suggests considerable plasticity on their part. But that isn't what's interesting about them. What's interesting is that somehow they have a predisposition to see your *clothes* as the important part of the images they monitored.

"Now why would a people look at your images and think it was vital to mimic your clothes and not your bodies?"

"Unadventurous fashion sense, I suppose," Hazel said, looking at Bekker's conventional apparel.

"Which would be a virtue, considering the manifest incongruities of an adventurous one," Dangorn said with a smile at Monpelie, gazing at the vi-

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brant and clashing colors of her dress.

"I believe it might be a predisposition born of their circumstance," Jeeger said. "Try to imagine a symbiotic relationship that might *compel* them to notice your clothing. In Terrene evolution, intelligence arose within the mammalian brain, hidden away and out of sight. But what if intelligence arose first as a function of hive-activity among some of the millions of single-celled organisms that live symbiotically within the mammalian body? Plausibly, it might arise among bacteria that communicate with one another as they travel through the host body. These might eventually find it in their interest, however, to cease their nomadic activity and to move into some kind of proximity. Where would they do that? More importantly, if this hivemind had a good idea of its host, where would they rationally *choose* to congregate? Likely they wouldn't choose the brain area, since that region would be needed by the host organism for its own uses. The body cavity might provide ample space; however, the skin would provide an even more likely spot, since it would allow for more growth, and would keep the individual cells of the hivemind in close contact with the largest single organ of the biologic being, the skin. That skin itself might have been the medium within which the bacterium first operated. Forming on the skin would have the added benefit of providing access to outside sensory stimuli, which might hasten the development of intelligence."

"So instead of hearts, those beings would wear their brains on their sleeves," said Metrio.

"After a manner."

"It would be a good adaptive strategy," Dangorn said, looking into the distance. "The intelligence could literally rub off on others. If the hivemind developed in one individual, it could spread rapidly through a population by simple bodily contact."

"I begin to see what you're saying," Bekker said. His voice had lost the tinge of nervous exhaustion that marked it before. "In appearance, these symbiotic beings would look to us like animals, or people wearing clothes, except the *clothes* would be the source of intelligence, whereas the part we would consider the *body* would be only the source of mobility and maybe even sustenance."

"But these people you've been puzzling over in Orbital Point *have* no bodies," Metrio said.

"Biological bodies, with their delicate internal organs and complicated systems, are difficult to transport," said Jeeger. "If you are in the beginning of space exploration, do you go through the trouble of sending out both parts of the symbiosis, or do you save yourself the trouble, and just send out the intelligent part of the symbiosis? If they are intelligent enough for space travel—and we know they are *that*, since they have come to Iaca to meet us—then they could easily find some way to sustain themselves artificially, without the host organism."

Hazel laughed. "So what we see as clothes—are actually *brains*. And those brains didn't bother to bring

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their bodies along for the trip."

"That's my suggestion, yes."

"Now wait," said Dangorn. "You said at first that it's *we* who are the invisible ones. What did you mean by that?"

"Simple," said Jeeger. "When these beings—these people—saw your images in the broadcasts they monitored, they were predisposed to see a symbiotic organism-pair, in which the encased being is little more than a pack-horse and source of labor. Say you lived in antiquity and were riding along a mountain path on your burro—"

"What's a burro?" said Metrio.

"A sort of donkey," continued Jeeger, "which was a diminutive, hardy pack beast related to the horse. A popular subject among artists of what was called the 'Old West' in the North American continent, some centuries ago. Anyway, if you came upon another traveler who also sat on a burro, would you waste any time trying to communicate with the burro? No! You would instantly look at whoever was riding that burro. For all practical purposes, that other burro would hardly exist.

"Similarly with these people. If they *are* as we imagine, then when they saw human images in a visual broadcast, they didn't notice the human body, face, or hands. They probably even disregarded the sounds produced by those bodies. All they noticed were the clothes, which corresponded roughly to their own state.

"And being plastic in nature, they *did* go that extra step of trying to make themselves look human, in order to make humans feel at ease. Thoughtful beings, aren't they? I imagine that once communication actually is initiated, they'll turn out to be cooperative, sympathetic creatures.

"But as I say, all they saw was your clothes. They figured the internal being, the human part, was insignificant, and they left it out in making themselves look human.

"And so," Jeeger said, turning to Bekker, "in your communication efforts, everything has failed. Why? Because you are invisible to them. They've been concentrating on your clothes all this time, trying to understand them and their movements, while you've been focusing on the fact that they're invisible!"

"I'll be galaxy jumped," Bekker said. "We've been invisible to each other. Invisible! The whole time! I've got to get word of this back up to the team. But we're faced with a whole new problem, aren't we? How in the world do we get them to see *us* and not our clothes?"

"Why not do it in the simple way, and show them that it's *you* who's in charge, not your clothes?" said Jeeger, picking up Hazel's tumbler for a refill. "Next time, go to them naked."

The following afternoon at the Cafe Henri, in the Hotel Humaine, might have passed quietly had not a small party been loudly celebrating the arrival of a message from Orbital Point.

The message consisted of only five words, addressed to Servitor Jeeger.

They were as follows:

"The emperor has new clothes." ■

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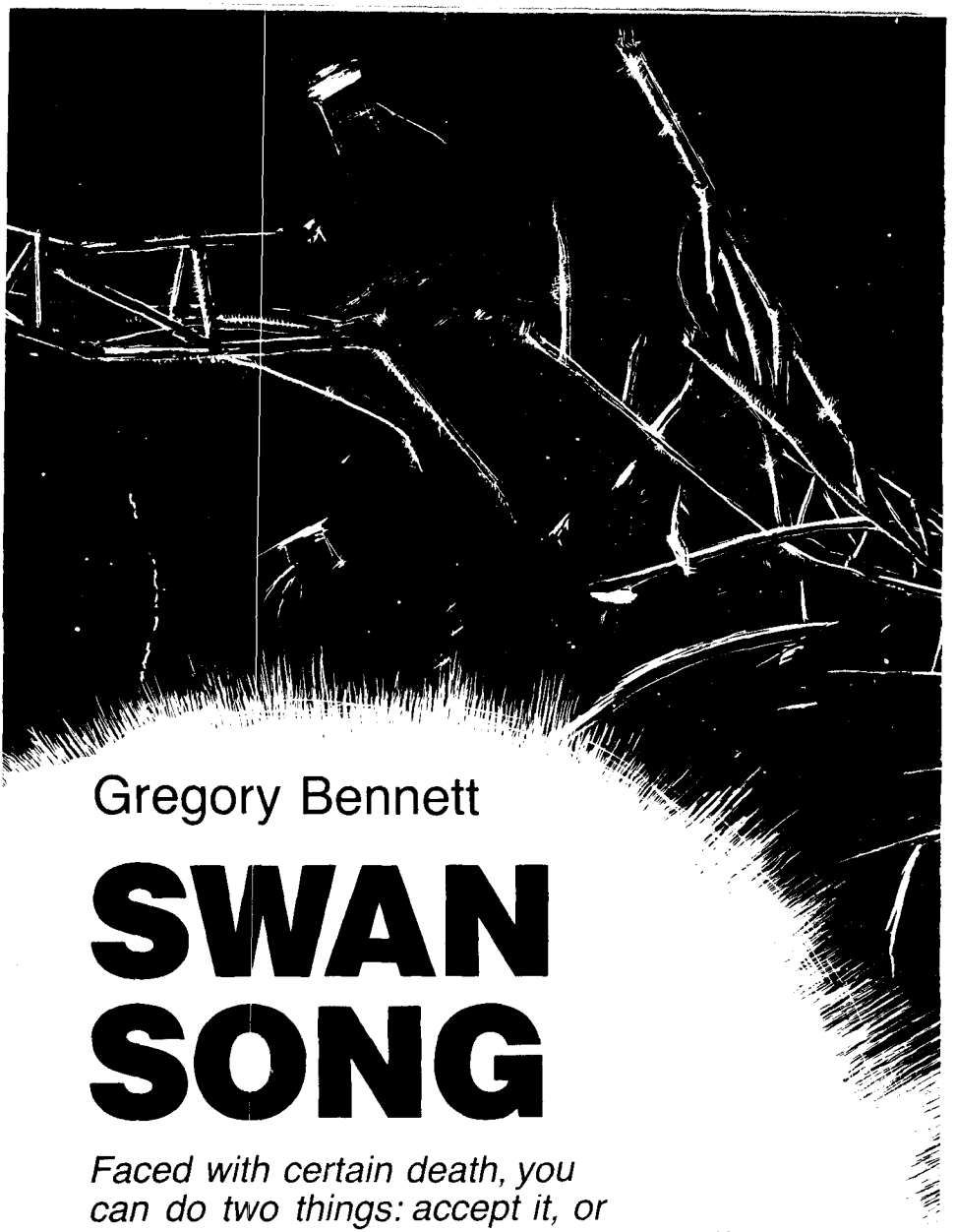

Gregory Bennett

SWAN SONG

Faced with certain death, you can do two things: accept it, or practice what you've always preached!

Illustration by Bob Eggleton

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Alone in the darkened control room of his interplanetary freighter, Bryce Thompson had watched the ruddy rockball grow from a member of the starfield to a dull gibbous moon. Mars circumnavigated his viewport slightly off center, marking the passage of time like the second hand of a badly calibrated clock. Its tiny moons were becoming significant bodies of matter, distinct from the ponderously turning mass of stars.

"Phobos and Deimos," Bryce whispered to no one but the unhearing moons. "Fear and Panic. It's a bit late for you dogs of war to show up. I tried it your way; didn't work. Got any other suggestions?" With binoculars and his imagination, he could see the dog-leg in the Mariner Valley. There, dug into the south wall of the giant rift valley, was home, a home he did not expect to see again.

The incident occurred three days earlier. After months of being happy and snug in his well-organized, machine-controlled environment during the flight from Earth, Bryce began to feel the bite of loneliness brought on by anticipation of his homecoming. He was discussing the final course correction with his ship, the *Boreas*.

"Our state vector agrees with Capri to seven decimal places," the ship said. Bryce thrilled to hear the name of his home town, even if only in the machine's strictly-business monotone. "We will need a course correction burn to align for Mars orbit insertion. Projected maneuvers exceed the envelope of my magnetic torquers."

Things happened quickly this close to his goal. In deep space, they'd spend an entire day on such a maneuver, using a magnetic field generated by loops of wire running the length of the ship to react against the plasma in the solar wind.

"OK, *Boreas*, reconfigure autopilot to use chemical thrusters. Check out the thrusters and maneuver to burn attitude. Go." Anticipation filled Bryce's chest. *Final course correction, Mars orbit insertion, and then home!*

Suddenly, a yellow rectangle appeared on his control display, highlighting a flashing message: FUEL ANOMALY.

"There is a low-pressure reading from all three sensors in the port fuel tank," the ship explained.

"Show me the time history, *Boreas*."

A graph on the display screen told the story—normal pressure around two hundred pounds per square inch until a few minutes ago, then a drop to nearly zero.

"Looks like we've had a serious leak in that tank," Bryce said "*Boreas*, isolate and purge port maneuvering fuel tank. When purge is complete, switch to low-pressure sensor on that tank. Go."

He slumped in his chair, rubbing his chin.

"*Boreas*, record my voice, packet name Willnote. Go.

"Will, I've got a problem with the fuel tank for my left-side attitude control thrusters. Either all three pressure sensors failed at the same time or the tank sprang a bodacious leak a

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few minutes ago. I'm attaching the time history of all the fuel tank sensors for the past twenty-four hours to this message. Will you see if you can figure out anything? It might save me some trouble when I get to Mars orbit five days from now. I don't want to have to insert at Mars by vectoring my torch, y'know.

"Thank Donna for the home cooking again. Tell Bert I'll have a berth for him on my next trip out if he keeps that grade point up and gets his degree. And thanks! End of message.

"*Boreas*, stop recording. Cut at 'end of message' and append the current propulsion system displays to packet Willnote. Transmit packet to William Bain via U.S. SpaceComNet. Go.

"*Boreas*, open packet series Outtagas. Begin procedure Outtagas. Store real time continuous all data from propulsion system into packet Outtagas—*what the hell was that?*"

Thud! Thump! Thud! The sound seemed to come from all over the crew module, accompanied by the staccato chirps of metal grating against metal. A cacophony of klaxons rang, buzzed, beeped, and screamed for his attention. The control panel rushed toward his face, but before he collided with it his chair slammed into his back. He was pushed sideways, then back and forth.

He grabbed the arms of his pilot's seat just in time to keep from being ejected headfirst into the forward viewport. One of the buckles from his shoulder harness swung around the chair and smashed against his elbow, sending a wave of shock up his arm and across his chest.

He involuntarily released his grip on the arm of his seat. Bryce snatched at his shoulder harness to keep from being tossed across the cabin. His left arm painfully informed him that it wanted to have no part in this operation.

There was a strange taste in his mouth. Not blood. Bile.

His control display was a teeming pile of colorful information windows, each vying for priority over the others. Bryce punched off the master audio switch to rid himself of the din of alarms. The control room fell silent; only the distant rush of ventilation fans masked his labored breathing and the pounding of blood in his ears. The ship's normal half-*g* environment was gone; Bryce had barely enough weight to keep him in his seat. A film of sweat clung to his face and arms.

Pop! Ping! Mild vibrations, like turbulence over Mariner Valley.

He unlatched a long-neglected keyboard and pulled it in place in front of him.

Bryce had already typed the command to purge all audio buffers when he changed his mind. Instead, he instructed the ship to dump the information into the same data packet. The shuffling deck of reports disappeared from his screen.

He switched on the audio system.

"*Boreas*, tell me about the life-support systems, please," Bryce requested. He used the polite command terminator, *please*, inten-

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tionally. It rankled Bryce to assign too much animism to a machine, but right now it felt a little less lonely to treat the machine as another person.

"One of my cryo oxygen tanks reports zero pressure," the *Boreas* replied. "I have isolated all oxygen tanks, but only number four reports damage."

Bryce subconsciously welcomed the computer's switch to personal mode. It was a superbly programmed machine, one of the finest products of Mars's computer software industry. Software, along with planetary data, designs for nanotech engines, fiction, and entertainment programs, was the primary product exported from Mars to Earth. Spaceships like the *Boreas* went down the gravity well Earth almost empty. They returned loaded to the gunwales with solid Earth goods exchanged for Martian data transmissions in a complex arrangement with Swiss banks and Pacific Rim trading houses.

Boreas continued, "Three port-side cargo pods, nicknamed Sneezy, Doc, and The Nursery, do not respond. All lines to the hub and starboard side are open, so I don't know anything about the hub or beyond. The access tunnel is at vacuum. Atmospheric regeneration looks good in the crew cabin and the remaining pressurized cargo pods. Do you want a detailed report?"

"No, thank you, *Boreas*," Bryce responded. "Give me a briefest summary of all systems, please."

"You have urgent messages from power management, propulsion, guidance, navigation, control, data management, fluids management, cargo status monitoring, external communications, and internal communications. Crew compartment waste management has a low-priority anomaly, but is otherwise happy."

"Oh great!" Bryce muttered. "*Boreas*, are there any systems that do *not* want to talk to me right away?"

"Yes, food preparation is all joy."

"Well, at least I can eat. *Boreas*, what can you tell me about the status of systems needed to do the course correction?"

"Manual inspection will be required to determine our status for the course correction burn," *Boreas* explained. "None of the required systems have sufficient data."

"How does the air look, *Boreas*?" Bryce asked.

"Atmosphere looks good. There is, however, a slight abundance of methane. You might consider skipping the beans at supper tonight."

Bryce was startled. A sense of humor in a ship's computer? There seemed to be a lilt in the machine's voice.

"*Boreas*, was that a joke?" he asked. Despite himself, he chuckled.

"Yes, it was intended to be a joke," *Boreas* replied flatly. "Analysis of the present circumstances indicated that subtle humor was appropriate."

"Uh oh," Bryce was again serious. "Your programmers probably realized that humor is most welcome in the presence of disaster. How bad is it? What are our present circumstances?"

"Bryce, I don't know," *Boreas* replied.

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"Huh?"

"I can maintain life support for not less than forty days. The galley is working 100 percent, allowing for recovering from having cake batter splattered all over the inside of the oven. Waste management is in good condition; I sent a new *g* profile which cleared the anomaly."

"That sounds like the good news," Bryce interrupted. "What's the bad news?"

"I don't know the exterior status of the ship," *Boreas* explained. "I have no data from the hub or beyond."

"How does the starboard hull look from here?"

"I don't know," *Boreas* repeated. "No data from exterior cameras. Mathematical analysis of our recent anomalous acceleration indicates that we are no longer attached to either the hub or the starboard hull. I am rotating at a rate of approximately one revolution per six minutes.

"Bryce, would you please look out the airlock hatch window? I need data."

"Of course. Right away." Bryce agreed. He unstrapped from his seat and pulled himself along handrails through the passage behind the command cabin.

"*Boreas,* what's our comm status?"

"Main antennas do not respond," *Boreas* reported. "However, I can continue intermittent communication with Earth by slewing the dish on the port hull. All requested outgoing communications have been completed, except for one incompletely programmed procedure."

"Huh? What procedure?"

"The procedure Outtagas currently ends with the phrase, 'What the hell was that?' I interpreted the final phrase to be not a part of the procedure, but rather a new interrogative which I am now pursuing with manual assistance from you. Is that correct?"

"Right on the button, pal," Bryce answered. "The gal who programmed you must be a real genius. If we make it to Mars, remind me to look her up and give her a big smooch."

"I'm sure you'll enjoy that," *Boreas* observed. "She's very pretty, and just your type."

"Oops, I didn't intend that to be a command," Bryce explained. "Besides, who told you she was pretty, and how do you know she's my type?" He was beginning to enjoy having a chatty computer. It took his mind off his worries.

"In answer to the first question—you told me," said *Boreas.* "My second observation is based on the interpretation of several facts. A pertinent fact is that you married her and have stayed married for more than twenty years; even more pertinent is that you are eager to get home to see her."

"And how do you know I'm eager to see—" Bryce began. "Belay that. I can report on your physical status. The hub and the starboard hull are gone. Looks like the truss was twisted off about halfway from here to the hub. The tunnel is shredded at the end, tangled up with the truss."

"That agrees with my math model of the incident," *Boreas* agreed. "Can you sight the remaining truss to im-

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prove the accuracy of the report, so I can remodel our ship?"

"Sure, lemme get the binoculars."

"We've got about eight hundred feet of truss left, bent back at an angle of, uh, twenty-eight degrees," Bryce reported from the airlock window. "The forward main antenna is still attached, but there's a big chunk of metal smashed into its base. Probably damaged its electronics box. Do we have a spare on board?"

"Yes," *Boreas* replied. "The spare for that unit is in the external avionics stowage locker. Bryce, I recommend an EVA to replace the antenna avionics box. We need that antenna to talk to Mars."

"OK, let's do it," Bryce replied. "*Boreas*, prep my orbit suit, and talk me through the pre-EVA checklist, please."

Two space suits, one white and one dark green, hung in crumpled folds in an alcove outside the airlock. The white one began to swell like an expanding balloon as Bryce reached into the suit locker to retrieve a small face mask and oxygen bottle

"If you intend to go EVA today, you will have to start at high pressure," *Boreas* informed him. "Take your aspirin now, and then start your prebreathe."

"Oh, right, I forgot the aspirin," Bryce replied. Aspirin would reduce swelling caused by the change to low pressure, and, he hoped, an extra tablet would help control the pain in his left arm.

With *Boreas* guiding him, Bryce dismounted a small television camera from the control cabin.

"Helmet sealed, comm check," Bryce told *Boreas* through his helmet microphone.

"Loud and clear. Inner hatch sealed," *Boreas* responded. "Go for airlock depress."

"Roger depress."

"I'm tethered outside now." Bryce kept *Boreas* informed of his progress so the machine wouldn't nag him about safety protocol. "The handrails on the truss look secure all the way to the antenna."

The sky was a rotating globe of bright stars, completely surrounding him except where it was eclipsed by the bulk of the ship. A long latticework of trusswork stretched out to the sky, shadows of one beam on another shifting crazily as the parts of the construction moved into sunlight.

"This is weird," Bryce reported. "Easy to get disoriented in this lighting, and—" He missed a grab for the next handhold. "*Whoops!* There's just enough gravity to mess up my reflexes! Gotta take it slow."

He struggled out along the truss with his equipment waving about him on short tethers. He was halfway out when *Boreas* announced, "I am receiving an incoming message from William Bain. Reception is intermittent; however the message is being repeated and I should be able to fill in the missing data with two more revolutions of the ship."

"*Boreas*, is there anything in Will's message I can use while I'm out here?" Bryce asked.

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"Mister Bain transmitted his message before he received any information regarding the anomaly which lead to this ship breaking up," *Boreas* responded.

"Of course," Bryce scoffed. "I forgot to tell you to send the Outtagas packet!"

"I took some latitude in interpreting your command which ended with the phrase 'What the hell was that,' Bryce. I assumed you intended to continue to send data regarding my status, so I am transmitting those data each time Earth comes into view of the hull-mounted antenna."

In a more stern voice, *Boreas* added, "Bryce, please be aware that your order to cancel all warning messages is still in effect. I have been able to resolve all current warnings against my new model of the ship's condition; however, I do not recommend that you continue to inhibit all warnings."

"Damn. I forgot. *Boreas*, cancel any warnings regarding equipment that is no longer attached to the ship, and resume normal caution and warning advisory, please. And remind me to talk to the avionics programmers about that when we get to Mars. A pilot should not be able to cancel all warning messages and then forget about it! But, *Boreas*, how is it that you came up with a warning about warnings if all warning messages are inhibited?"

Boreas explained, "Should a situation arise which increases danger to the ship, I am able to advise the pilot. I am still, however, unable to take any independent action unless the pilot is incapacitated."

"But you decided to send those messages to Will Bain without a specific order."

"My analysis indicated the probability was near unity that you would want me to send the data to Mister Bain." The computer's tone was almost defensive. "I had an incomplete order, twice interrupted by higher priorities set by the pilot. My decision was supported by historical precedent—all data regarding anomalous performance of this ship's systems are transmitted to that same address. I had no countermanding order and no higher priority tasks for the systems involved in completing the order. I incurred no cost in executing the transmission; the data are being transmitted without instructions for processing by Mister Bain's organization."

Bryce had reached the damaged part of the trusswork. The spidery vision of a huge dish antenna, now bent at an awkward angle, sparkled in the slowly changing sunlight just a bit farther out.

"*Boreas*, why didn't you tell me you could do things like that? You could have made my job a lot easier all these years!"

"Bryce, you enjoy doing your own thinking," *Boreas* explained. "For that reason I anticipate and execute only trivial orders, such as instructing the robots to perform routine external maintenance on the ship. The task of routine external maintenance has been greatly simplified since I am unable to influence any part of the ship outboard of where you are now."

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"Only a computer could think up a silver lining like that!" Bryce retorted.

He took a long look back along their trajectory, but saw nothing but the starfield. Somewhere out there was the rest of the ship, the hub with its nuclear rocket, the starboard cargo pods, the robots which had been Bryce's only companions these past several months. He fought down feelings of regret; he would have to wait until later to mourn the loss.

"I'm at the antenna now," Bryce said. "The truss is badly twisted out here. Feels solid, though. My tether slider stuck on the handrail about thirty feet back, so I'm letting the tether run out of my reel. I think I can still reach the antenna."

The computer's response was a flat monotone, "EVA flight rules warning regarding tether protocol: Make Before Break."

Bryce chuckled. "Thanks, Mom!"

"This is really the end of the truss, *Boreas*. Two more bays of twisted spaghetti, and that's it. The access tunnel has been stretched out like a piece of taffy here, broken loose from its attachments. Here's a good one, though—some of the lights are still on in the tunnel! Speaking of which, with the nuke gone, where are we getting our power?"

"Fuel cells on the service module provide primary power for the port hulls," *Boreas* answered. "Electrical power from the isotope reactor was used only to recharge the fuel cells."

"Now how is it that I managed to fly this baby for seven years and not know that?" Bryce asked.

"You have completed the lesson on the electrical power system nineteen times," *Boreas* informed him. "However, you would have had to work two levels lower in the details before you learned where the electricity is actually generated."

"*Boreas*, log a note for me to gripe about the text when we get to Mars. Thanks. I'm at the antenna now."

"Bryce, I would like to be able to see," *Boreas* requested.

"OK. I'll see if I can plug the camera in first."

Minute vibrations came from the camera through Bryce's gloves. He could see the zoom and focus rings moving. The pan-and-tilt head gave a few spasmodic jerks.

"Bryce, I can focus the picture, but I am not able to stabilize control of the pan-and-tilt unit."

"That's because I'm still holding the camera," Bryce explained. "Hold off control inputs until I find some place to strap this thing down."

For the first time since the *Boreas* was assembled, Bryce wished he had specified common hardware interfaces for both internal and external equipment. Some wide, gray tape —purchased at a dear price on Wilson Station though it looked suspiciously like common duct tape— served to secure the camera's mount to a junction of truss members.

"Give the camera a try. I'm moving toward the antenna's avionics bay, so you should be able to see me." He continued working while *Boreas* played with the camera.

"OK, I've replaced antenna electronics. I had to knock a big, flat

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chunk of something out of the structure to get at the connector, so I'm not sure it'll work."

"The antenna reports nominal status. I will wait until you are clear before attempting to slew it toward Mars."

"Too right! Lemme get out of here."

"Bryce, can you describe the debris which you removed from the antenna structure?"

"It was some sort of composite. Yellowish brown on one side, silvered on the other. Some kind of rubbery black sheet clinging to the yellow side, stuck on with black goop. Lots of cords hanging out of its edges. Curved, guess about a five-foot radius. Does that sound like anyone you know?"

"Yes, it matches the construction of the main maneuvering propellant tanks," *Boreas* observed.

"Looks like we've found our culprit, not that it matters except to the engineers at home. I suppose the insurance company will want to know, too. I'm on my way back. Next stop, the cargo pods."

"Bryce, I have assembled the complete message from Mr. Bain now."

"Let's hear it."

Although the communications system automatically controlled the volume level, Bryce could hear the strained tones of shouting in the incoming voice.

"Message to Bryce Thompson, the *Boreas,* near Mars. Priority: Immediate. From William Bain, Lawrenceville, Illinois, via the Guthrie Group headquarters transmitter, Chicago, Illinois. 24 July 2086. Message begins.

"Bryce, we've looked at your propellant tank data. Our model shows you might have overflow into the rigid insulation collar for the cooling jacket without actually depressurizing the tanks themselves. That could cause an apparent three-sensor failure. Those sensors are mounted between the tank and the insulation collar, and they measure relative, not absolute. Of course, they expect vacuum on their backside. At any rate, we don't recommend attempting to purge the tanks, since you'll wind up pumping propellant into the insulating collar instead of venting it to space. And do not—repeat, do *not*—use your low-pressure gauge if you've already tried to pump down the tank!

"Our maintenance records show that the sensor package installed on that tank is the wrong model. It's probably what caused the leak, but especially watch out for that low-pressure gauge. That gauge uses a hot wire; it counts the number of gas molecules bouncing off the wire every second. If there's still fuel in the tank, *ka-blooie!* So again, do *not* use the low-pressure gauge on the port maneuvering fuel tank!

"I'll key this message to repeat until acknowledged. Donna said she'll keep the coffee on the back burner for ya, and Bert says he's ready to go now! Good luck, pal, and give my best to the family!"

"The whole cargo is insured, full value for freight on board at Wilson

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Station," Bryce told his son. "Our customers' only loss will be another year's delay until they get their goods." With the high-gain antenna back in operation, he could put through a phone call to his home on Mars.

He waited a few seconds for Geoff's response, glad of the communications delay; it gave him time to think.

"What do we need insurance for?" Geoff asked. "It was an Earth company that installed the wrong stuff in the fuel tanks, so act like an Earther—sue the pants off 'em!"

"Sue Wilson Station? In an Earth court? Tell me another one!" Bryce scoffed. "Besides, we have to stay friends with Wilson; they're the only free enterprise transportation node left in Earth orbit!"

"Wasn't there some irreplaceable stuff in the manifest, Dad?" Geoff asked.

Bryce wished he could have full video, like on Earth, but few Martian phones were equipped for transmitting pictures.

"There are some collectable books, but they're stowed in the crew module. I don't think anything else in the cargo was really irreplaceable. None of the animals was unique—they were all proven stock from New Zealand. And don't forget I've still got most of the cargo in the port pods.

"But it's not the cargo I'm worried about; it's the ship. It'll be a long time before we'll be able to get the *Boreas* in shape for another cargo run to Earth. When are we going to get another torch with all the interplanetary freighters owned by the Japanese? There's no way they'll sell one of their ships to us! Well, there must be something we can do with the old *Boreas* to keep the Terry Toys coming. All I gotta do is get the ship into Mars orbit and unload what freight I still have with me."

"Hey, Dad, how are you going to dock with Panicsville when you get to Mars? Didn't you lose your maneuvering jets along with the hub?"

"They'll come to get me," Bryce assured him. "Hey, don't you have some homework to do? It must be getting pretty late."

"It's Woden's Day, Dad," Geoff reminded his father. "And it's nine o'clock in the morning here. That's why mom and Holly aren't here; they're at Meeting."

"Oh yeah, I was looking at the Greenwich clock," Bryce mused. "Are you feeling OK, Geoff? Why didn't you go to Meeting today?"

"Remember that paper on alternative launching systems Bert was helping me with? It's due tomorrow. I thought I'd better stay home and polish it up so I can transmit it tonight. Doc Hesper is always in a better mood when he's starting to grade a stack of papers, so I want to be the first one in the stack."

Bryce laughed. "That's my boy! Keep squeezing the odds in your favor, and you'll go far! OK, I'll sign off and see what Panicsville thinks about the trajectory. Talk to you tonight, say about eight, Capri time."

"Bye Dad. Want me to send you a copy of the paper when I get it done?"

"You bet! I'll enjoy reading it. And

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if it's as good as it damn well better be, I'll send it on to Will Bain. He's good at getting technical stuff published. It wouldn't hurt to add a bit to your account in Switzerland. Bye now."

Despite the assurance to his son, Bryce Thompson was not at all confident his arrival at Mars would be a graceful one. Without his nuclear rocket, he had no way to add to velocity needed to match orbits with Mars.

Boreas predicted they would swing high, past Mars in an elliptical orbit around the Sun. They eventually would approach Earth, but long before his ship got there, Bryce's life support systems would have run out. He would be a long time dead.

"*Boreas*, can you get me a voice line to Panicsville?" Bryce asked

"Panicsville is on the line, Bryce, with slow-scan video," *Boreas* responded.

A still picture began to form on the comm screen in Bryce's crew quarters. He saw the top of a head, with auburn hair loosely pulled back and gathered into a long braid. Ten seconds passed, but no voice answered his greeting. The picture showed a mischievous glint in the greenest eyes Bryce had ever seen, confirming his suspicions about who was manning the comm shack at the space station in Mars orbit.

"Xena!" Bryce exclaimed, "What a delight for an old man's eyes! How's the tourist business?" He composed his face into what he hoped was a friendly smile, and selected the TRANSMIT SINGLE FRAME option on his comm display.

"Welcome home, Bryce!" Xena Shepard replied. "Your active nav isn't responding, but I have you on skin-track radar. Don't bother to explain; your data dump tells the whole story. And, since you asked, even without the Terries, the tourist business isn't as bad as you'd think. I'm booked up; four rooms rented to Martian families who are up for the grand tour, and the rest taken by spacers. If this keeps up, I'll have to sweet-talk the Robinsons into leasing me some more space!"

This was the closest contact he had had with another human being in months, and he intended to enjoy every second of it. He put off asking the question foremost in his mind, hoping to stretch out the happy pleasure of reacquainting himself with an old friend.

"That's great!" Bryce exclaimed. "I worried that the lack of manned flights from Earth would put you out of the business."

"Oh, we don't get the shiploads of horny Terry scientists any more, but the asteroid miners and the locals are a fairly steady clientele. I haven't had to buy my own emeralds and rubies, yet." Bryce could almost hear the wink in her voice.

"So tell me what I've missed these past two years," he requested. "Who's head of the council now? And—er, Xena, what's this picture you're sending me?"

A merry laugh filled the *Boreas* crew quarters before she responded, "It's a welcome-home present from

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me to you, Bryce. Something special for a sailor who's spent half a year alone at sea."

Bryce's interest had been building with each incoming scan line. Low gravity did wonderful things for a woman's figure, especially those like Xena whose mammalian heritage was obvious even from a distance.

"I couldn't have asked for a better gift," he said, selecting the SAVE FRAME BUFFER control without really thinking about it. "You are even more beautiful than I remember, Xena. It looks like styles have loosened up even more on Mars while I've been away! Or is that a prerecorded photo?"

"Nope, that's me, just as I am right now. Not my usual mode of dress, I'll admit, but right now I'm alone in the comm shack. Everybody else is either at Meeting or up in Traffic Control running options on your trajectory. But don't get your hopes up! Styles haven't changed that much in the last two years!"

Her comment about his trajectory brought Bryce back to reality. "I guess I'd better ask how my trajectory looks," he said. "My nav system's gone, so I don't know where I am or even how fast I'm going."

A long pause, then "Well, Bryce, here's what we think. If you don't do any propulsive maneuvers, you'll arrive at Mars in a little over four days. But you're on a hyperbolic trajectory, way too fast to be captured in our gravity well. And, um—"

Bryce didn't want to believe it, so he again called up his astrogation display and had *Boreas* plot his path through space. No surprises; it was exactly as Xena had told him. He tried to swallow the lump in his throat, but it wouldn't go away.

"What else, Xena?" he croaked.

"Bryce, your current trajectory doesn't take you past Mars; it goes *through* it! With no course changes, the *Boreas* will smack into the surface somewhere around Marth crater."

"Uh, does anybody live around there?" It was all Bryce could think of to say.

"Nope. Nobody."

"Good."

The radio was silent for a few moments, not even carrier static. Then Xena came back, quietly.

"Hugh Barton, from Traffic Control, has an idea. Bryce. He thinks you might be able to alter your path using your spin-up rockets. That's what they've been working on up there. You might have enough delta V to miss the planet, go over the north pole."

"Got anybody in a position to come get me if I overshoot?" he asked.

"No, not a thing."

"Nothing from the asteroids? Or from Earth?"

"Can you hold out seven months?" Xena queried.

"No. Ninety days at the outside. *Boreas* and I have gone through it in detail."

"Meridiani days or Greenwich days?"

"Does it matter?"

"No."

"Xena, let me run this through my on-board computer. He's got a pretty good math model of the ship built up

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now. I'll get back to you as soon as I've figured out what to do."

He switched off. It took a few minutes for the initial shock to wear off. When emotion returned to him, it was a heavy blow to his chest. He sobbed involuntarily, squeezing his eyes tightly shut to stop the tears that threatened to form.

"So I'm a dead man," he muttered to himself. "Few people know when their time will come. But thanks to the miracles of modern technology, I can predict the moment of my death to the nearest millisecond."

This was one mystery of life Bryce wished he did not know.

For the next hour, Bryce sat strapped into his chair. He flushed his trajectory display, and recalled the single frame Xena had sent to him. He gazed at the image for a few minutes and then let the screen dissolve back to a photograph of his family. He and Paige had been married for twenty years—

Good years, nearly all of it. Oh, we had some hard times along the way, like when we put every farthing into outfitting our own pressure and had to pay rent to a landlord. But even then we weren't worried; we knew we'd make it.

Wonderful times. Two fantastic kids, both of them beautiful, cheerful, bright. Headstrong, maybe; certainly self-assured. But that's the way we wanted them to be! Mars doesn't tolerate any but the strongest, the best. Nothing's going to stop Geoff; I'm sure of that. Geoff has that uncanny knack for beating the odds, injecting sound engineering into hare-brained schemes to make them work. That patent on his new process for using solar energy to manufacture nitrogen tetroxide for rocket fuel— Oh! That was a glorious day!

And Holly. A couple more years of undergraduate work, then med school. Never enough doctors on Mars. Maybe Albert Bain will make the trip up, get something going with Holly. No need to worry about Geoff; half the girls in Capri are already wiggling their assets at him.

Only two kids. Paige and I were lucky to have a boy and a girl to raise. But now, with pressure extending miles more every year, there's plenty of room. Room to go back to the big, open commons, like the first colonists. Room for more babies. We were even talking about raising a second family. I was looking forward to that—diapers, first words, first steps, stories and lessons and skinned knees and a sense of wonder that never stops—

Well, Paige will be OK. She's still beautiful, and wealthy enough. There aren't a lot of eligible bachelors around, but we have lots of close friends. Polygamy is getting to be more the norm in Capri anyway. She'll find somebody to help her get her new family started.

Damn! Should have left some of my own genes on deposit before I took this trip! I might not have thought this problem up, but I should have considered the radiation at least. Oh well, too late for that now. Paige will be OK.

* * *

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Bryce discussed their predicament with his ship. With the starboard side gone, the maneuvering rockets would cause the *Boreas* to spin like a top. But by carefully firing them at the same time in each revolution, Bryce could add linear velocity in the direction he wanted to go. Fuel left in the feed lines would give him a few seconds of thrust, but it wasn't enough to miss the planet, much less to enter Mars orbit.

A message from Will Bain suggested he use propulsive venting. Will's model showed that Bryce could avoid hitting Mars entirely if he hosed his air and water supplies out the waste gas vent. The idea buoyed Bryce's spirits momentarily, until he realized the scheme completely eliminated any hope of being rescued by another ship. If he turned his air supply into a cold-gas rocket, he would have nothing left to breathe.

Bryce was faced with two equally unpleasant fates. He could use up his air and suffocate, his ship becoming a derelict that might be salvaged by somebody, some day. Or he and his ship could become a smouldering mixture of aluminum, with trace contaminants from a few tons of cotton and his own precious pink body, splattered all over Marth crater.

The chances his family would be able to salvage the *Boreas* from a long orbit around the Sun were too remote to consider. That way lead only to slow suffocation long after all hope was gone. The alternative, which really meant that no action was required from him, was to go out, quite literally, in a blaze of glory, leaving behind a new crater as a monument to remind spacecraft designers and repairmen to do good work. His family might even profit from the resultant fame; he was confident Geoff would figure out a way to exploit his father's demise just for the pure pleasure of the mental gymnastics required.

Except for the diversion provided by working through the engineering, Bryce did not seriously consider altering his trajectory. The decision was easy for him, and once made, left his mind surprisingly free and unworried.

He indulged in a few hours of regret, reviewing in his mind all the plans he had made for the future, and then dismissed them. Those plans no longer had any bearing on his existence. There was nothing he could do to change his fate, and the only obligation he felt toward the Universe outside his little spaceship was to send a few messages of strength to family and friends.

For the first time in Bryce's life, his mind was truly at peace. Few have the luxury of knowing the moment of their own deaths; most do not even believe in it.

He would have enjoyed human companionship during these last few hours, but Bryce wanted to avoid endless maudlin conversations with his family. He considered calling Xena, but decided not to add another burden to her life, either. It would all be over, for him and for them, in a few days. He felt confident that he would be fondly remembered, and that was as much as any man could

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hope for.

Shunning even the company of *Boreas*, Bryce switched off the audio circuits throughout his ship. He considered shutting off all the clocks, too, leaving only a single display with a dramatic countdown to impact, but decided to stay on Greenwich time. He didn't want to switch to Mars time; it would constantly remind him of his family, remind him to wonder what they were doing at each moment. It was past midnight, Greenwich time; long past bedtime, time to relax and call it a day.

Bryce settled in for the night with a bulb of coffee and a piece of cake from the bizarre patchwork his galley assembled after the accident. Several hardbound books were part of his cargo, a prepaid special order from a collector in Capri. They were worth a king's ransom on Mars, so Bryce had accorded them the special treatment of being stowed in the crew module, right next to his bed.

Those old novels were still securely held in place by a strap across the front of his bookcase headboard. They were all original hardcovers, books from a time on Earth when space was a new frontier to be conquered instead of political pawn to be held hostage. Pity about Earth, but the Martians knew how to do it right. On Earth, people worshipped professional athletes and named things after politicians. On Mars they recognized builders and innovators, and named things after Bradbury and Clarke and Heinlein. He reached for a leatherbound edition of *The Past Through Tomorrow*, but then thought better of it. He might not have time to finish the book. His fingers traced along the titles and stopped at *Have Space Suit, Will Travel*. He drifted into sleep while happily trekking with the book's characters across the surface of the Moon.

For two days, Bryce luxuriated in having no worries, no pressures, no stress. He ate and read and exercised, played games with *Boreas* (beating the machine in chess for the first and second time), and dictated part of an autobiography that he might or might not transmit before he arrived at Mars. For him, it was a peaceful, happy time; a time of acceptance, a time of frivolity.

Then, with two days left, he found himself strapped into his pilot's chair in the *Boreas's* small control room, watching Mars slowly circumnavigating his viewport. Something prickled at the periphery of his mind, intruding on the Nirvana state he had achieved upon acceptance of his own impending death—something left undone.

Reluctantly, he reviewed his preparations. He had had his "chin-up" discussions with his wife and children. He had sent last messages to everyone he thought might need one; young Albert Bain even sent a message back, letting him know that the accident on the *Boreas* hadn't discouraged him from his dreams of space travel.

There was no point in worrying about funeral arrangements; when he entered the Martian atmosphere, the temperature in the control room

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would hit a million degrees—never mind what temperature scale is used to measure it—and his body would be vaporized far more efficiently than any crematorium could do. Maybe Paige would get some money back from their prepaid niches in the Hall of Remembrance at Capri. No, she would probably keep the niche, so that a little stone plaque on its door could add his name and some clever bon mot to that museum of the dead.

Money should be no problem. There was money in the bank at Capri, and more in the bank in Zurich. Insurance would cover the loss of the cargo, and his life insurance policy on Earth would be enough to put two more loads of luxury goods and machine tools on their way to Mars, wholly owned by Paige and the kids.

His will was rock-solid. There was no wolf at the door.

So, financially, at least, his family should be better off than if he had lived. In the long run, he probably would have made them a lot wealthier—but there were no long runs left. What was left to do?

He thought about his last messages to the kids. It was too late for lengthy summaries of all the philosophies he had taught them from birth; they either had it by now, or they never would. Bryce wasn't worried, they had it. Those messages had been just right, no discussion of their futures. They were adults now—their futures belonged to them. Their minds would have enough difficulty relinking all their thoughts of the future, editing him out of the picture, without more complications from deathbed utterances. His only role in those futures would be as a memory, an icon.

Abruptly, Bryce sat upright in his pilot's seat. With vicious stabs at the circuit breakers, he punched in the cabin audio circuits.

"*Boreas*, evaluate probability of survival, this vessel, in atmospheric entry at Mars. Go," he commanded. Memories of the most important lesson he had taught his kids hammered in his mind. It was always the same lesson, repeated in a thousand ways almost every day since they were infants.

Squeeze the odds.

The ship's computer responded immediately. "This ship does not carry an atmospheric entry model. Request permission to purchase one from traffic control at Panicsville."

Of course it's silly to carry a gun while prospecting alone in the Mangala Outback. That's why I do.

"Permission granted. Go. *Boreas*, with atmospheric entry model, calculate optimum trajectory for the entry of this ship. Parameters: optimize probability of survival for the crew. Go. *Boreas*, get Panicsville on the phone, full video if bandwidth available. Go."

Write that letter to your councilman, even if it's just another tick mark on a clerk's tally sheet.

"Request for atmospheric entry model transmitted," *Boreas* answered. "Panicsville responding with full video."

Make your resumé easy to read.

The comm shack snapped into life on Bryce's central screen. To his dis-

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may, the room was empty, but Xena Shepard's voice reached him through the audio circuits.

You'll never wet your wick if you don't ask her, Geoff.

"Hi, Bryce! I'm on my way back to the comm shack. I'd just finished eating dinner. I left a notice that I wanted to get to talk to you if you called."

Xena sounded cheerful and alert, but there was a low-pitched thickness in her voice that told Bryce she had been asleep moments before. He felt a tiny pique; as far as he knew, Xena had never lied to him about anything before, not even a little white one. The notion quickly passed. What are the rules for talking to a dead man?

An extra string of redundancy in the ship's life support won't cost much more, Paige. We can afford it.

"Very thoughtful of you, Xena," Bryce responded. "Sorry to disturb your dinner; there's no hurry." Like hell there isn't. But conversations with Xena are something to be savored, even now. Especially now.

Xena appeared from the right corner of his screen. Her hair was unbraided, tied with a green ribbon into a long, flowing pony tail. The only hint of makeup Bryce could detect was in the darkness of her eyebrows and eyelashes. She flowed into the comm shack's only chair; a vision of long legs ending in microshorts scrolled past his screen.

If you really want him, Holly, throw your whole body into that kiss. Make sure he gets the message.

Bryce let out a slow wolf-whistle, hoping it would carry across the communications link.

Vitamin pills won't hurt you, and they're cheap.

Xena grinned in response to his expression of appreciation, and asked, "What can I do for you, sailor? You in town for the whole convention?"

The ship's computer interrupted briefly, to report, "Atmospheric entry model has been retrieved. No cost incurred. I am integrating the new model with the existing data for this ship."

Always lift with full tanks.

"Xena," Bryce asked, getting down to business, "do you still have those calculations of how much delta V I can get from propulsive venting? I want to know if I have enough to alter my entry to four degrees below the horizon."

You can spot the safety engineer easily—he's the guy wearing both suspenders and a belt.

"Let me get the traffic control room patched in. This might take a minute."

Bryce imagined the Panicsville engineers rousing groggily in response to the plaintive wail of the alert screamer in their rooms and hurrying in their pajamas—or whatever people slept in on Panicsville these days—to the traffic control room. The night watch might already have a few things going; there was always something going on in orbit around Mars. But this would be something new and exciting—an adventure for the orbital mechanics guys and the rocket engineers.

Never skip a walk-around inspection before you take your car outside the pressure.

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"OK, the guys in traffic control are on the line," Xena told him.

"*Boreas*, this is Joe Canfield," a deep baritone said. Xena stayed on the video. "Are you seriously considering a controlled entry with a deep-space craft?"

"That's about right," Bryce responded. "It's the only chance I have."

Take the seat nearest the back door.

"Well, I don't need to tell you what your chances are," Joe Canfield said. "The *Boreas* is not an atmospheric craft, and you know it. But to answer your question, yes, you still have time to alter your course to achieve an entry angle four degrees below the horizon. Are you trying to execute an aerobraking maneuver, or do you want to go for a complete grounding?"

"I don't know," Bryce responded. "I hadn't thought to try for aerobraking to orbit. What sounds best to you?"

Get all the advice you can from the experts, and then do what feels right to you.

"Aerobraking to orbit gives you a lot more room at the end of the maneuver. Even if the part of the ship you're in manages to survive entry, you'll still hit the ground at over four hundred miles an hour. But if you make Mars orbit, even a high-inclination, highly eccentric ellipse, we can get someone to you within two days."

"So what's the catch?" Bryce asked.

"An aerobraking maneuver would be tricky," Joe Canfield explained. "You have to hit the entry right, and then control your aerodynamics to lift back out of the atmosphere once you've traded off enough velocity for heat. Chances are you'll wind up hitting the ground anyway."

"Got any ideas on how to control this beast in the atmosphere?" Bryce asked. "I don't even know what the ship will look like once it hits air."

"Not a clue. I have some advice, though." He paused.

Count the cards you can see.

The leading pause told Bryce something unpleasant was coming. "Go ahead."

Get out before the crisis starts. Don't wait.

Canfield came back with, "Go for the night side. That buys you two things. First, you'll have a few hundred feet per second less velocity with respect to the atmosphere when you enter. And second, your landing footprint will be in an unpopulated area in Utopia instead of wiping out half the folks in The Valley."

Head for the softest thing you see, even if it's a solid wall. The wall might not be that solid, and there might not be anything on the other side.

"But, *Boreas*—Bryce—you'd do better either to use up all the reaction mass you can find and miss Mars entirely, or just leave it alone and hit square. Your ship isn't equipped to control its velocity vector by venting cold gas. You'll have almost no accuracy in where you're aiming. You can attempt a controlled entry, but I wouldn't bet on it."

Weigh your gamble against what you stand to lose. If you can't afford to lose it, don't bet.

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"It's all I have to bet on, Joe," Bryce responded quietly.

"Oh, Bryce—" Xena choked back a sob.

"Xena, will you do something for me?" Bryce asked gently. "Make sure my kids know that I went down fighting the Grim Reaper every step of the way. But wait until it's over. Don't let them suffer through two days of false hope. Somebody will have a memorial ceremony. Tell 'em then, so they'll remember."

"OK, Bryce, I will." Her voice was solemn, almost a whisper. Bryce could see the dew forming in her eyes.

Clean the wound and disinfect it, even if it looks clean. Use a bandage.

"Joe, what do I have to do to get myself lined up on the night side?"

—and who knows? The horse might learn to sing!

Bryce drove himself for two sleepless days. He had *Boreas* record a running narrative describing everything he did; the messages could be transmitted later to Panicsville to fuel the imaginations of those who would second-guess him when it was all over.

He had to fix his trajectory first, to set the *Boreas* on a course which would neither collide directly with Mars nor skip off the planet's atmosphere into oblivion. Even if everything went precisely right, the odds were that no part of the ship would reach the ground intact, but he had to try.

Breathing gas would be his rocket fuel. Working in his space suit, Bryce scavenged parts from his water reclamation system to construct a makeshift thruster. With a bit of wiring—tricky business for a man working in space-suit gloves—*Boreas* was able to control the flow of gas through the nozzle.

Bryce unbolted the remaining main truss and jettisoned the cargo pods. Anything that reduced the total mass of the ship improved the chances the little rocket could shape their trajectory in the direction they wanted to go.

Each parcel dumped into space was a personal tragedy for Bryce—expensive electronics, exotic foodstuffs, pharmaceuticals, machine tools, seeds, frozen embryos. Everything in his doomed cargo was precious beyond price to the Martian pioneers, but he saved only those few items which might help him survive.

The inside of the ship was a maze of shifting junk salvaged from the cargo; Bryce had run out of time to tie things down. The longer he waited to correct his course, the more gas would be needed to do it. It was time to use the cold-gas jets.

Bryce sat in his pilot's seat for the maneuver, not quite sure what to expect. It was anticlimactic when it came, a gentle push from the side of his chair accompanied by the image of Mars rocking back and forth in his view port.

"*Boreas*, the Universe doesn't look very steady today."

"There is a wide deadband in the attitude control jets," *Boreas* explained. "Repeated, opposing thrusts are required in the roll axis to keep the main propulsion system aligned

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correctly."

Bryce smiled. The ship had adapted its old terminology to its new set of thrusters. The main propulsion system once was a huge nuclear rocket engine that would push the ship—the whole ship, not just this remaining fragment—all nearly a tenth of a *g*. Now it was a collection of plumbing, spare parts, and hope.

He watched the trajectory correction until he got bored with it and succumbed to his eagerness to get on with the rest of his work. With just over a day to go, there was no time to spare.

Most likely, he and his ship would end in a ball of fire at the highest reaches of the Martian atmosphere, but there was nothing he could do about that and no way to plan for it. Most of the *Boreas* was doomed; its aluminum skin would burn away in the incredible furnace of friction between the ship and the atmosphere. But there was a chance that a well-insulated fragment of the ship might survive all the way to the surface, and Bryce intended to be inside that fragment.

A twin-hulled liquid nitrogen tank was the innermost part of his life boat. Its brightly polished stainless steel outer shell was designed to withstand continuous exposure to space, where intense cold, the burning Sun, and micrometeorites bombarded the tank throughout its life. Rigid foam insulation separated the inner shell from the outer one. Bryce hoped the tank's insulation would not be a factor in dealing with the heat of entry into the planet's atmosphere; he was more interested in the ability of the foam to crush on impact.

He suspended the tank near the front of the crew module by thin wires running to the ship's framework. Working one-handed to soften the protests from his left arm, he chopped up everything he could find that would move.

His construction grew until it filled the forward module and blocked his access to items at the front end of the lifeboat, so that as each layer burned away, the lifeboat would weathervane to keep its back to the wind. Of all the equipment in the aft crew module, only the airlock and the contents of its lockers remained inviolate.

Bryce floated in front of the locker next to the airlock's inner hatch, examining his surface suit. The suit was an old friend; it had a name.

"Wake up, Gus," Bryce said, a bit louder than he intended.

"Hello Bryce," the suit's voice intoned. It sounded distant, emanating from the open faceplate of the helmet. The arms and legs of the suit moved a bit. Self-test. "I'm feeling well. How are you?"

"I'm doing great, Gus," Bryce responded, "except for some pain in my left elbow that limits the range of motion of my left forearm." One does not tell diplomatic lies to a powered suit, not when the suit expects to respond to every muscle movement.

"I'm sorry to hear about your elbow, Bryce," the suit answered. "I'll try to take good care of you. Are we still in orbit? I cannot get a fix on the gravity vector, and appear to be in my

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locker."

"Right, Gus. You're still in your locker aboard the *Boreas*. You'd better ask the ship about our present situation while I pack some stuff."

Bryce left his suit to discuss their predicament with the *Boreas* while he assembled the rest of his chattels. If he successfully landed, he was going to be in the wrong place, a third of the way around Mars from the nearest human settlement. He would need supplies for survival.

Oxygen and water were already stored in Gus. Food was another matter. Gus carried some food supplies, candy bars mostly, inside his helmet and upper torso. But since Bryce might be trekking across Mars for weeks, he packed all the food he could find that might survive exposure to the thin surface atmosphere of Mars. He dumped plastic bags loaded with food and water into a satin sheet from his now-defunct bed.

A small open tunnel was all that remained of his control room; he had filled the rest of the volume with junk. He rolled the sheet into a cylinder and pushed it ahead of himself through the access tunnel.

An octant, normally used for stellar navigation on the long trip between Earth and Mars, would perform the same function on the ground. Aluminized blankets might save his life, becoming his only protection from the radiation of a solar flare. In a pinch, he could throw dirt on top of a blanket and hide underneath until the flare subsided.

And the books. They had brought Bryce through a long, lonely trip from Earth to Mars. With luck, he could take them all the way to the red planet.

Two extra pairs of overboots went into the lifeboat; it might be a long walk. These were accompanied by the helmet from his orbit suit. He couldn't mount the helmet on his surface suit, but it had extra lights and a radio he could patch into Gus just in case. Tanks from the orbit suit's life support system would provide that much extra oxygen. Mars charts and maps, a basic tool kit, and two automatic pistols in their holsters went down the tunnel.

Last to go into the tank were all the soft things Bryce could find—pillows, woolen blankets, seat cushions left over from his construction project. He didn't have an emergency pressure tent, but the flexible bladder from one of the *Boreas's* oxygen tanks might give him a chance to get out of his suit once in a while. He overloaded his lifeboat on purpose; he wanted it packed so tightly that he would barely be able to move. Gus would provide some protection from having his limbs flailing about when the little ball hit the surface, but Bryce doubted that even a powered suit could hold its own against the accelerations he expected.

"Entry interface in exactly one hour," *Boreas* announced.

It was time to get dressed for the show. One of the best things about a surface suit was its roominess. Spacecraft airlocks were necessarily small to reduce their mass, so orbit suits had to be similarly confining. But surface locks could be as big as they

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needed to be; the only cost was the time it took to pump them down. Gus was roomy enough that Bryce could get both hands inside the suit, an incredible luxury on long treks when he had to wear a suit for days at a time. He could eat, manipulate things stowed inside the suit, take care of personal needs, and even scratch his nose, all without the need to seek surrounding pressure.

For this ride, however, the last thing Bryce wanted was extra space inside his suit. It just meant that he would bounce around, getting bruises or worse from contact with the suit's interior equipment. His solution was extra underwear. Bryce put on the undergarments from both his suits, along with several layers of normal underwear and sweat suits, and finally two pairs of pajamas on top. The resulting bundle make him look as if he were already wearing a space suit as he squeezed himself into Gus. It was a tight fit, but it was supposed to be.

"Welcome aboard, Bryce, it's been a long time," the suit said.

"Thanks, Gus, it's good to be back. *Boreas*, communications check."

"Loud and clear, Bryce," *Boreas* responded.

"How long do we have?" Bryce asked.

"Twenty-nine minutes." Both the *Boreas* and Gus answered Bryce's question, in perfect unison.

"Oops! *Boreas*, let me talk to Gus for a minute," Bryce said. "Gus, let's try moving a bit. I can't move very well in this get-up, so you might have to help me more than usual."

Before releasing Gus's backpack from its rack on the wall, Bryce tried moving his limbs. First one shoulder joint, then the other, followed by hips, elbows, knees, feet, and fingers. It took just over a minute for both Bryce and Gus to be satisfied that the suit's control algorithms had been properly adjusted for the operator's lack of mobility.

"*Boreas*, how's our trajectory?" Bryce asked.

"As close as I can measure it, we are in the center of our planned window. Panicsville reports that we are on course."

"You can still talk to Panicsville? I thought we lost them when we lost the big dish," Bryce said.

"We are now close enough to Panicsville to use omnidirectional UHF," *Boreas* explained. "We will pass quite close to them, within two hundred miles."

"OK, great," Bryce replied. "*Boreas*, send a message, text, not voice. Ask Panicsville to tell my family I love them, and, uh . . . that's enough. And send a personal to Xena Shepard. Tell her it's been great, and I hope she'll look up Paige and the kids the next time she hits dirt. And, uh, yeah, tell her I love her, too. Send the messages to Panicsville's computer, not to Xena, with a delay of thirty minutes before delivery."

"That way they'll know your last thoughts were of them," Gus observed.

"Yeah," Bryce agreed. "But we still have work to do. *Boreas*, how long?"

"Twenty-two minutes."

"Time to get rid of the atmo-

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sphere," Bryce said.

"Venting," *Boreas* reported.

Bryce took a last look around the interior of the *Boreas*. There was not much left to look at in his old ship. The interior had been wrecked beyond recognition, and the viewports were obscured by the enormous glob of junk he had constructed. The most interesting remaining item was a long snake, more than two feet in diameter, which he had made to plug the access tunnel left in the layers of insulation. The snake was essentially constructed in the same manner as the rest of the insulating layers, starting with blankets salvaged from the cargo pods, and ending with whatever was at hand. Throughout were parachutes, any large chunk of cloth Bryce could find tied at the corners to long pieces of wire. The parachutes might slow his flight through the atmosphere before they were ripped away, or they might not; at least they improved the odds.

The entire conglomeration was wrapped with a web of wire. Bryce hoped the wire mesh would constrict its contents small enough that it could be dragged through the tunnel after him, but would allow the plug to expand under deceleration when the ship hit the Martian atmosphere to effectively plug the tunnel.

Fully suited in Gus, seals tight, Bryce started to crawl into the access tunnel. He stopped at the entrance and asked, "*Boreas*, do you want to be shut down? The automatics can handle it from here. I could switch you off, or even yank out your CPU or memory module or whatever; maybe take you with me."

"Thank you, Bryce, but it isn't necessary. I will feel neither pain nor remorse during the breakup of the ship. I am not programmed for pain, and there can be no remorse in fulfilling the rest of my program."

"But I hate to lose you, buddy," Bryce protested.

"Thank you, Bryce, but you are no longer able to gain access to any of the equipment that would be needed to preserve this machine entity. Your path is blocked by the thermal shielding with which you have filled the crew module. Time is short, Bryce; please enter your lifeboat now."

"How long?"

"Ten minutes."

"OK. Gus, give me some help with this plug."

Bryce crawled along the tunnel with only his helmet lights for illumination. He pushed his backpack ahead of him and dragged the plug into the tunnel behind by a line tied around his waist. He paused just outside the metal sphere to attach the parachute wires to his lifeboat.

"Comm check. Everything OK, *Boreas*?"

"Signal weak but clear, Bryce," *Boreas* responded. "Warning, cabin pressure is now below five pounds per square inch. Your suit is critical for life support. Good-bye, Bryce. And good luck."

"Goodbye, *Boreas*. It's been a wonderful seven years."

"Yes, it has. Six minutes. Close your hatch."

Bryce climbed into the steel

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sphere, head first. He had to leave his backpack outside the hatch while he dug a Bryce-shaped niche in the life boat's stuffing, but with Gus providing the extra power, he eventually managed to squeeze himself and his backpack inside. He left only his right hand with enough freedom to operate a ratchet wrench to bolt down the cap. With a tap from the wrench, the cap swung into place on one bolt, and Bryce started inserting the rest of the fasteners.

"*Boreas*, comm check."

No response.

"*Boreas*, comm check," he tried again."

"The ship cannot hear you, Bryce," Gus told him. "I am receiving no data from outside the life boat. We are again alone in our own small universe."

"I guess you're my universe now, Gus. If only you could keep the rest of that other universe out of this one."

"I feel confident, Bryce. You did excellent work on insulating the life boat."

"Thanks, Gus. Wanna play chess?"

"Pawn to Queen's Bishop three."

"Huh? Pawn to King four."

"Pawn to Queen four."

"What are you up to, Gus? Pawn takes Pawn."

"I'm trading my Queen's Bishop's pawn for your King's Pawn, Bryce. Pawn takes Pawn."

"Yeah, but now your pawn is a sitting duck—uh oh, here we go."

Everything in Bryce's lifeboat shifted as weight returned. It started as a gentle push against his back, accompanied by a distant hissing in his headphones. Sound could not penetrate the multiple layers of hull, heat shielding, tank, and space suit; it must be coming from the electromagnetic radiation generated as a plasma built up in front of the *Boreas's* crew module. The push was slightly against his side, so he squirmed around inside the tiny space and rearranged his makeshift cushions for better support. Bryce realized he should have fastened down the padding in the lifeboat, but it was too late for that now.

His little room started vibrating, and with the vibration the gentle push became a hard shove. Bryce carefully laid his head against the thin pad at the back of his helmet, admonishing himself for failing to immobilize his head and neck. The room spun left, then right. He slammed against his suit.

There goes the crew module's outer hull. Goodbye, *Boreas,* Bryce thought. Phobos tugged at his mind. Rational agnosticism abandoned him; he prayed to the Moon. *Take my fear, Phobos.* Deimos twisted his guts into a knot. He fought it down. *No panic, no panic, nothing I can do. You panic, Deimos, I don't have time. I'm busy.*

Boom! The lifeboat lurched violently, tossing cushions and Bryce up toward the hatch and then back down again.

Something hit us, probably the forward docking collar. Or maybe the control panel. Calm, calm. I'm not scared I'm not scared I'm not scared Phobos take my fear Deimos give me calm.

Then, to his surprise, he was being

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subjected to a steady, heavy hand against his back, with random motions no worse than heavy turbulence he encountered flying his airplane over Mariner Valley. The outer layer of the heat shield was rapidly heating up, boiling off, he hoped, layer by thin layer instead of ripping away in large chunks. No burn-through yet; Bryce waited for a white-hot torch to cut through his body, but the heat shield continued to protect him. He hoped the epoxy he used to hold the insulation on had hardened upon exposure to vacuum; if not, it would simply serve as a lubricant, helping the protecting layers of makeshift composite material to slide away in the torrid blast of wind flowing past his craft.

The cushions pushed harder against him until he weighed more than a ton. A vibration underlying the feeling of turbulence actually felt good, massaging tired muscles which could no longer move even his fingers. He used all his strength just to breathe, forcing air from his lungs in staccato wheezing draughts. Pain faded into numbness. Bryce gave up on fighting the acceleration and tried to allow his body to go limp. *Deimos give me calm.* He wished for a window and was glad he did not have one. Perhaps he succeeded in relaxing, but with every part of his suit feeling as if it were made of granite with biting bits of gravel here and there, he felt no difference.

He was startled when a dark silhouette suddenly appeared against faceplate, backlit by his helmet lights. A roll of cotton tied up with light nylon cord was plastered against his helmet like a giant amoeba overcome with rigor mortis. He could only hope that the structure of his helmet would hold it; a failure now would drop that cotton onto his skull like a fifty-pound chunk of rock. *Phobos take my fear.*

Bryce's world divided into two ghostly images. It lost its color, fading to a monochrome pink, then red; he was approaching blackout.

Bryce squeezed his hands into fists as best he could in the bulky gloves. Gritting his teeth to keep his jaw from slipping back he tried to force out a few words. "Shuss . . . jusss . . . G'G'Gusss . . ."

"Yes, Bryce?" The space suit responded in a perfectly normal voice.

"Rizz . . . rig . . . id'd'd . . . ice . . . all . . . sh'shoindz"

"OK, Bryce."

He did not know if Gus understood his command to rigidize its powered joints; he had no way to tell. The suit felt as rock-hard and immobile as before.

"Zhusss . . . s'day . . . dusss . . ."

If Gus responded with a status report, Bryce never heard it. He had blacked out.

Discontinuity.

The lifeboat was violently tossing him around, rolling head over heels, slamming first into one side, then the other. A moment of free fall, then the cushions hit into him from an unexpected direction, again and again. His head hurt. His neck hurt. His left elbow hurt. His chest hurt. *Everything* hurt. But the rolling and pounding went on.

Abruptly, everything stopped. Everything but his head. Shore sickness;

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the world continued writhing in his mind long after the lifeboat came to rest. He struggled to figure out his orientation. Bryce was beginning to feel warm inside his suit. Warm and cozy. Maybe just a little nap would help him clear his head.

Someone was speaking to him. Gus's voice.

"Bryce, it's time to wake up now. Bryce, it's time to wake up now. Wake up, Bryce it's time to wake up now."

The droning of his wake-up alarm had been speaking to him since the discontinuity, but only now had it been able to force its way into his conscious mind.

"I'm awake, Gus," he said dully. Then, "Gus! Gus! I'm alive! I'm *alive!*"

"Good morning, Bryce," Gus cheerfully replied.

"Gus, report suit status," Bryce commanded. It was a reflex, the first thing he thought of after taking a tumble in his surface suit.

"Life support is green, but the secondary oxygen supply is not available for emergency use. Pressure sensors indicate the supply line from the secondary oxygen tank has been disconnected. Suit pressure integrity is green. Four hours twenty-six minutes oxygen remaining in primary system, assuming normal surface excursion activity. External temperature is 240 degrees and rising. As we are in a closed environment, I cannot use evaporators for cooling. The thermal capacitor will reach saturation in twenty-nine minutes. External pressure is seven atmospheres absolute. Orientation of the suit cannot be determined precisely—my gyros have tumbled. Accelerometers indicate we are in a head-down attitude at zero point three seven four plus or minus seven normal *g*. Without gyros, I cannot determine rotational rates except for with respect to the gravity vector. Drinking water supply is empty, apparently due to a failure of the water bag—"

Bryce noticed his hair was wet.

"—mechanical systems reporting green, but cannot be tested while I am rigidized. There are several medical alerts."

"Gus, report medical." Might as well get the bad news before relaxing the powered joints. That rigidization might be the only thing standing between Bryce and death from a severed spinal column.

"Current vital signs are good; however, recent accelerations indicate a high probability of damage to internal organs. There is a significant probability of subdural hematoma due to accelerations in the region of the head. Minor spinal compression is indicated, but not likely to be serious except in the region of the neck. Probability of minor contusions is very high. Joint compression at hips is very likely."

"I can move my head, but my neck hurts," Bryce said. They went through a catalog of the pains and odd pressures he could detect by concentrating on each part of his body. He felt a mounting thrill of relief as he learned his spinal cord was intact and there did not appear to be any broken bones. But he couldn't check his own joint functions while

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the suit was rigidized.

"Gus, relax all joints," Bryce commanded.

Pain! Everywhere, pain!

With all the extra padding inside his suit, Bryce might as well have left his supply of pain-killers on Earth. It was one more thing that couldn't be helped. He gritted his teeth and asked, "How long until thermal saturation?"

"Eighteen minutes, Bryce. I recommend we get out of this enclosed space."

"OK. I don't think I can walk, but at least I can touch the dunes one more time before I die!"

The suit normally cooled itself through evaporation, boiling off water to carry heat away with the vapor, but the evaporation system would not work against the high pressure and temperature inside Bryce's lifeboat. Gus was using his backup thermal capacitor, a bag of chemicals which slowly changed state from solid to liquid as heat energy was dumped into it. Without his suit, Bryce would have been long dead, having survived intact all the way to the surface of Mars only to be boiled alive.

But in eighteen minutes, the suit's thermal capacitor would become saturated, unable to absorb another erg of energy. The lifeboat was now threatening to become his coffin.

It took Bryce a few precious minutes to find his socket wrench among the clutter inside the tank, and then another minute to shove cushions out of the way so he could position the wrench on the bolts and have enough room to work the tool.

The nut on the first bolt would not budge. He tried the next one. No luck. Finally, with all the help Gus's motors could give him, he got one of the nuts to move. It was slow going; the force required to move the wrench against the fastener's torque remained high even after its initial breakout. When the nut finally came loose, the bolt it had been retaining shot out of its hole, propelled by the internal pressure of the tank. Bryce's external microphones picked up the sound of the atmosphere whistling through the bolt hole.

"Outside pressure and temperature falling rapidly," Gus informed him. "Revised estimate of time to thermal saturation is one hour, four minutes."

"OK, pal, let's get these bolts off."

Bryce found it easier to move some of the fasteners as the tank's pressure dropped, no longer pushing the hatch outward against them. Gus revised his time estimate each time Bryce opened a new hole. But three of the nuts refused to turn no matter what he tried. He kicked at the hatch, but the recalcitrant bolts held it secure.

"It's not working, Gus. Any ideas?"

"Can you reposition me so I can use my legs against the wrench?" Gus inquired.

"Good idea!"

Squirming around inside the life boat was a challenge; with each motion, Bryce had to rearrange bits of padding and equipment. Movement was painful, but hope of surviving at least long enough to get outside buoyed Bryce's spirits. Finally, after solving the three-dimensional puzzle

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dozens of times, he had a boot positioned on the wrench.

"Ready, Gus. You do the pushing. Bring my right foot back, max power."

He felt his right leg flex involuntarily. Then, *tink!*, free movement. Gus kicked hard against the wall of the life boat, propelling Bryce into the cushions piled on top of him.

"I think we did it, Gus!" Bryce cried. Again, he wrestled with the padding until he was turned around enough to see the hatch fasteners through his face plate. His hopes were destroyed by what he found.

"The nut didn't move, Gus," he reported. "We broke the handle off the wrench instead."

"Shall we repair the tool?" Gus inquired.

"How?"

"Weld it."

"We don't have a welding rig, Gus," Bryce replied.

Almost a minute went by before Gus suggested, "Bryce, would you like to finish our chess game?"

"Not right now, Gus," Bryce replied wistfully. "Let me take a nap."

"Good night, Bryce."

He awoke to a banging noise from outside. A voice came faintly over his radio, almost lost in static, "Dad? Dad? Are you in there? Dad?"

It sounded like his son! But Geoff should not have been there. Bryce had been careful not to let his family know that he planned to attempt an atmospheric entry in a ship designed never to leave the vacuum of space. He had not expected it to work, and did not want them to suffer through the days of false hope.

Loud chattering drowned out the voice in his headphones. The steel tank rang like a demented gong. After only a few seconds of this, the hatch cover flew away. Space-suited figures were frantically digging his padding out. Gloved hands grasped his legs and tugged until he slid out of his lifeboat.

He had landed on the night side of Mars, but the area was illuminated with dazzling artificial light. He was on his back, looking up at his rescuers. Their faces were obscured by their helmet visors, but Bryce recognized the markings on their suits —Holly and Geoff, his daughter and son. They rolled him over on his side toward his lifeboat, and he heard his life-support pack latch into place.

The tank had come to rest with the hatch pointing downward toward the rocky Martian soil. The books, their plastic storage bags puffed out in the thin Martian atmosphere, lay amid the detritus of his packing material.

A hug in a space suit is usually quite unrewarding, but to a man who never expected to be hugged again, the embrace of his son and daughter was the most exquisite pleasure Bryce could have imagined. They babbled about his experiences and how happy they were to see each other as the children—legally adults on Mars—helped Bryce walk to their jumpbuggy. While they were strapping him into a stretcher, another buggy landed. Paige came running out of it, and the tearful welcome-home ceremonies were repeated.

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From the jumpbuggy, Bryce could see the wrecked remains of the once-proud space freighter. A tiny battered sphere, blackened and scarred from its ordeal, lay on the ground surrounded by tatters of scorched insulation. The jumpbuggies' landing lights picked out the long furrow he had plowed through the rusty rocks and soil of Mars.

Paige pressurized the buggy so they could remove their helmets. Kneeling beside the stretcher, she kept Bryce awake by kissing him. Between smooches, Bryce asked, "How did you know I was going to try for an entry? Or even where to find me? Did Xena—"

"Nope, not Xena," Geoff answered. "We knew you'd try something, Dad, but *Boreas* told us when and where."

"*Boreas*? The ship? I didn't think he could override a specific order not to transmit that information."

"He didn't, actually," Geoff said. "What he transmitted was—well, I'd better let him explain it."

"How can *Boreas* explain anything?" Bryce asked. "He must have been vaporized within seconds after we hit the atmosphere!" He realized he was speaking into Paige's nose, but she didn't seem to mind.

Holly was fiddling with the jumpbuggy's radio, speaking in a voice too low for Bryce to hear. She looked over her shoulder at him.

"Dad, you can ask *Boreas* yourself now. I've patched him in through the cabin audio."

"Hello, Bryce," *Boreas*'s voice came from a speaker on the control panel. "I have several prerecorded memoranda for you. You want to complain to the—"

"That can wait!" Bryce interrupted. "*Boreas*, where are you? *Why* are you? You should be gone, just atoms floating in the exosphere!"

"I followed your programming, Bryce, to do anything possible to improve the odds of your survival, and to maximize potential profit," *Boreas* explained.

"I programmed you for that?"

"You did, more than forty-eight hours ago," *Boreas* told him. "The profit-optimizing routine has been part of my core functions for seven years, but the survival routine was added to it when you transmitted your last voice message to Panicsville Station."

"I don't get it, *Boreas*. How could I be talking to you now?"

"I twinned myself, Bryce. This software is too valuable to be lost due to a hardware failure, so I transmitted my program kernel and supporting data through Panicsville to the laboratory machine at home. I did not hear the order not to inform your family of your plans, Bryce, and apologize if I have made an error in judgment—"

"You did very good!"

"Noted. My twin, the version of me left behind on the ship, did not inform me of that order. After the twinning, the only information I received from the ship was its orbital parameters and status.

"My decision to inform your family of your intentions and probable grounding location was based on calculating methods to enhance the

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probability of your survival. This was necessary, as it is not possible for a protein being to twin himself in the time available."

"Huh? You mean it's possible for a human to twin himself?"

"As I understand it, yes, but imperfectly. The process involves conjugation of mature zygotes, and then a period of information transferral by audio-visual means. It is a lengthy process, which I believe you have been involved with for several years."

Bryce laughed. It hurt. "*Boreas*, you're talking about having kids! You still have a lot to learn, my friend!"

"That is true," the machine agreed. ■

IN TIMES TO COME

Our September cover illustrates the fact article, "The Hypersonic Skyhook," another of Robert Zubrin's innovative ideas for making access to space an everyday thing. As usual, he's thinking big, starting with an idea often proposed and then dismissed as impractical, and banishing the objections by putting a spin on it that not many would have the nerve or imagination to consider.

The fiction runs the gamut from past to far future, via the present. Duncan Lunan has an unusual protagonist in "With Time Comes Concord," an aircraft accident investigator with an even more unusual problem: what do you do when the plane that's crashed hasn't been built yet? If you're Lunan's hero, you start making long-range plans, hoping to do something *way* beyond your usual call of duty. And if you're reading the story, you'll get a fresh perspective on just how much our own reality has changed in the last few decades. . . .

The lone pilot in Jerry Oltion's "Course Changes" is a crash investigator of sorts, too, though he never planned it that way. Far from timely human advice, he has to make more than one kind of course change on his own and without much time to consider. What would *you* do if you made the first alien contact, but the alien in question was recently deceased, not necessarily alone, and much too close to home?

I don't have room to tell you about the other stories—by Linda Nagata, W.R. Thompson, Bud Sparhawk, Daniel Hatch, and Ian Randal Strock—but I think you'll enjoy discovering them for yourself!

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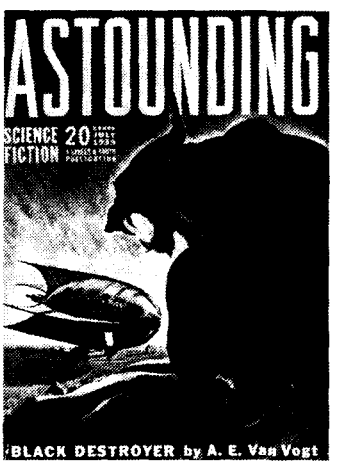

Critics mark this issue as the first "great" issue edited by John W. Campbell, Jr. It contains the first published story, "Black Destroyer," by A.E. van Vogt and the first story by Isaac Asimov to be published in **ASTOUNDING.**

This hardbound facsimile of the July 1939 issue also contains an Epilogue in which A.E. van Vogt, Asimov, and Rocklynne comment on their own work, their feelings towards **ASTOUNDING**, and especially their relationships with John W. Campbell, Jr.

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Kingdoms of the Wall, Robert Silverberg, Bantam, $22.95, 307 pp. (ISBN:0-553-09309-6).
Prophet, Mike Resnick, Ace, $4.99, 256 pp. (ISBN: 0-441-68329-0).
Fossil Hunter, Robert J. Sawyer, Ace, $4.99, 220 pp. (ISBN:0-441-24884-5).
The Architecture of Desire, Mary Gentle, ROC, $19, 208 pp. (ISBN:0-451-45234-8).
If at Faust You Don't Succeed, Robert Zelazny and Robert Sheckley, Bantam, $11.95, 325 pp. (ISBN:0-553-37141-X).
Demons Don't Dream, Piers Anthony, TOR, $19.95, 304 pp. (ISBN:0-312-85389-0).
Omni Best Science Fiction Two, Ellen Datlow, ed., Omni Books (324 West Wendover Avenue, Suite 200, Greensboro, NC 27408), $8.95, 250 + vi pp. (ISBN:0-87455-278-8).
The Art of Robert McCall: A Celebration of Our Future in Space, Introduction by Ray Bradbury, captions by Tappan King, Bantam, $60. 150 + x pp.(ISBN:0-553-07355-9).

Picture, if you will, the village of Jespodar, set at the foot of a massive mountain, Kosa Saag, the Wall. The village is one among many. The people who live there are flexible of form—shape-changers reminiscent of those we met on Majipoor—and their minds are dominated much less by their distant king than by the over-looming Wall atop which, their legends say, live the gods. Indeed, thousands of years before, the First Climber went up the mountain, all the way to the distant summit of Kosa Saag, and met those gods. They gave him such gifts as fire, and every year since then the people have selected forty of their best and brightest to retrace that holy ascension and return with more gifts. Unfortunately, it has been a long, long time since anyone returned in his or

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her right mind.

As Robert Silverberg's **Kingdoms of the Wall** begins, narrator Poilar Crookleg is relating how he and his best friend, the physically weak, inquisitive Traiben, swore as children to reach the summit. As the time when the Forty of their age-group will be chosen nears, that seems a silly vow, but they are indeed selected and sent off with banners and hooplah. What's more, Silverberg indicates that the chosen Forty are chosen not because they are some sort of elite but because they are those the community can do without —troublemakers, intellectuals who might rock the boat, leaders who might lead in untraditional directions. Perhaps Kosa Saag is only an excuse, a way to make exile look like an honor.

Are there parallels in our own world? Think of the exigencies of making a living, which distract from the drives to lead or achieve or create. Pick some kid with a way of asking awkward questions, make him or her valedictorian, graduate him or her summa cum laude from some good college, give him or her a good job, a spouse, a house, and some kids, and watch him or her settle into stasis.

Do the climbers settle into stasis? Watch as Poilar and the Forty he leads go up the mountain. At first the ascent is easy. There are signs that their people once lived higher on the slopes than they do now, but the hazards are few and manageable. They progress. They find that the Wall they know is only a foothill, and the peak rises and rises and rises above them, with no summit ever in sight. They find settlements of monsters, previous climbers who fell prey to the snares beside the way or gave up and built homes and had families. Stasis indeed. The ordinary, set high in the world, at best only thinly disguised by the trappings of success.

It becomes very clear that very few persevere all the way to the summit. And those who do go mad.

Why? That's not a question I can answer without giving away far too much. So far, Silverberg is being very clever about criticizing our society, saying that it has fallen, that it casts out its best, its truest strivers, that it so arranges things that those strivers are best rewarded when they cease to strive and become complacent, when they fall into sycophancy, when they succumb to routine. He is also hinting that those who persevere despite all the pressures upon them to conform do not find the satisfaction they crave. In fact, if they ever reach the goal of their quest, they are crashingly disillusioned.

The tale moves right along, propelled by sex and monsters and precarious situations. It holds the interest, and ultimately it satisfies. Yet the analogies *are* a little obvious—less so than in a *Pilgrim's Progress* but still blatant enough to make the reader grimace at the periodical feel of Silverberg's thumb in his ribs.

Prophet, the third volume of Mike Resnick's Oracle trilogy, brings to a close the career of Penelope Bailey. We first met Penelope in *Soothsayer,* when she was a mere tyke pursued

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by criminals, aliens, and agents of the Democracy (the government in the galaxy of Mike's *Santiago* and other novels). What made her so valuable was her talent for seeing the future. Or *futures*, really. She didn't see just one future, but many; she also saw those acts of her own that go with each future and could therefore, by performing those acts—a sneeze, a sidestep, a gesture—bring the desired future into being. There was no suggestion that her acts somehow caused the futures she produced. The relationship was one of coincidence that, because it could be seen, could be manipulated. No one pretended to understand it (not even the author). It simply was. And that was enough to make poor little Penelope the most sought-after maguffin in the history of literature. She was also remarkably hazardous to the health of those around her, for she was a typically self-centered child.

Yet even the most brattish kids do grow up. By the time of the second volume, *Oracle*, Penelope was an adult. She was also the exploited prisoner of the alien Blue Devils on the world of Hades, and her driving motivation was her need to escape. There were also hints that she had a plan to fulfill, a plan that did not necessarily take human welfare into account at all. She was as dangerous and frightening as an elemental force.

Now here's *Prophet*. It opens as someone tries—unsuccessfully, of course—to assassinate the Iceman, the one-time spymaster who is the only man ever to survive an encounter with Penelope. The would-be assassin is the latest of several in recent months. Pissed, the Iceman sends his bodyguard, the Gravedancer, off to learn who is behind them. The Gravedancer soon learns the responsible party is The Anointed One, a religious demagogue who is raising a huge army to conquer the Democracy. The two meet, and The Anointed One reveals that "In the entire galaxy, there is only one force capable of standing against me . . . [The Iceman] presents no threat to me whatsoever. But he is the only person ever to survive an encounter with my only true opponent. If she has a reason to let him live, then I care not what that reason is—I want him dead . . . She is the Prophet."

Who is the Prophet? Where is she? She is Penelope, of course, even though the Democracy is convinced that she died when Hades was destroyed. The Iceman, however, knows that she is indestructible, for she can always see and bring into being a future in which she survives. Yet he feels obliged to confront her one more time, just as soon as his minions can locate her.

We have known since the beginning that Penelope Bailey would never live to grow old. We have suspected since *Oracle* that she had a mission that she felt driven to fulfill. Now we learn that Penelope has long felt alone, unloved, shunned even by cats and dogs and other animals who flee her as if she were a forest fire or other elemental catastrophe. We learn that she is miserable, and that she has empathy. We learn just what her plan is, and it turns out to be a

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small thing, strangely altruistic in a self-centered way, and really quite fitting considering her plight.

How does she die? Resnick intimated in *Oracle* that she was growing in power, becoming able to see and manipulate further into the future, that the further she could see the more futures there were for her to make sense of, and that there had to be a limit on how many potential futures she could handle. That limit plays a role here, but not a crucial one. Far more to the point is that she seems to have achieved her plan. Her life is done.

Yet the galaxy cannot yet breathe freely. The Anointed One is still on the loose, and . . .

Hmm. Resnick assures us that this trilogy is done. Maybe he has another one in the back of his mind?

In *Far-Seer,* Robert J. Sawyer introduced a world of intelligent dinosaurs, the Quintaglios, evolved from predators like small cousins of *Tyrannosaurus rex* and handicapped by intense territoriality and ferocity. They were capable of social cooperation, but only at arm's length, so to speak. Sawyer's story concerned the appearance of Afsan, a genius who combined the insights of Galileo, Newton, and other luminaries of human scientific history, and his discovery that his world was doomed: It was, it seemed, the moon of a gas giant planet, and it would soon approach so close that it must shatter. To survive, the dinosaurs must flee to some other world.

Fossil Hunter, the sequel, moves the tale of escape along. Afsan, now blind, is adviser to the emperor, Dy-Dybo. His mate is the head of the exodus project, charged with developing the necessary technology and interested in learning how to fly. Their son, Toroca, a nonterritorial mutant, is taking inventory of the world, learning what resources will be available to support the exodus. In the process, he is paying attention to fossils, wondering why the deepest layers of sedimentary rock hold no signs of life at all, why shells and bones and such seem to appear all at once, why creatures seem to give rise to others greatly unlike them yet based on the same basic plan, why the world seems so much older than claimed by legends of a recent creation. He is a Darwin figure, and his approach to a theory of evolution by means of natural selection is a large part of this book.

Yet there is more. Always, in the past, the blood-priests had culled seven out of each hatching of eight eggs in the name of population control, leaving only the supposed fittest. The one exception, kept quite secret from the public, had been the royal family. Afsan, for his glorious achievement, had been rewarded with a similar exemption from the rule for his children. Yet now someone is murdering his kids. Dy-Dybo's brother has come from the province he rules to assert his greater fitness to be emperor. Afsan has convinced Dy-Dybo to slim down, shape up, and invite all his sibs to stand with him before a blackdeath (a full-sized tyrannosaur) to be culled (or not, as fitness dictates).

And Toroca has found a strange

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blue artifact, of some substance harder than diamond, embedded in the rocks just where the first fossils appear.

The meaning of the artifact is no mystery, for Sawyer tells us very early in his book that there is a being watching over our Universe and transplanting samples of life taken from Earth at various stages of its history. The mystery is what will happen next, for the book ends with Toroca in a new position that will mean great changes for his species. And there are other sentients in the Universe, all derived from Earth's biological history, all—including humans—awaiting discovery.

Fossil Hunter is a very interesting piece of work that many readers will find quite satisfying on its own. Yet much of its interest lies in what it promises for the future. It is a bridge between the very enticing first entry in the series and Sawyer's goal, whatever that may be. I'm looking forward to finding out.

Those of us who pay most of our attention to SF are nevertheless aware that fantasy exists and that certain authors have reputations as great as those of our own favorites. One of those authors is Mary Gentle, so famous for *Golden Witchbreed* and *Rats and Gargoyles* that I, for one, have wondered what I've been missing.

So here's her latest, **The Architecture of Desire,** in the mail, and let's see what all the fuss is about.

To put it briefly, this one is another medievaloid fantasy, but with a difference that lends it some distinction. The scene is England. The time is the mid-1600s, when in our world King Charles and Oliver Cromwell were duking it out for the hearts and minds of Merry Olde. In Gentle's vision, however, we have Queen Carolus and Olivia Cromwell in parallel positions. Magic is a potent force, especially in the hands of Masonic magi such as the fat Lord-Architect Casaubon and his wife, the Scholar-Soldier and Master-Physician known as the White Crow. As the tale opens, these two are being visited in their wintry manor house by a corps of gentlemen mercenaries, come to fetch the Lord-Architect to Olivia, and a single woman, Desire-of-the-Lord, come to fetch the White Crow to aid the Queen's flight into exile.

Once in London, the Lord-Architect learns that Olivia needs magical help to build the temple known as the Eye-of-the-Sun; success is essential to validate the rebels' ascendancy. The White Crow learns that the Queen's flight is desired by both sides, for if she remains the ensuing battles must damage the land even worse than has already been done. Both strive to carry out their missions, but the tale is complicated by rape and rape, conspiracy and betrayal, rescue and flight and a renewed sense of destiny for the White Crow if not for her husband.

There is an intricate and subtle imagination at work here, expressed in a story rich with sex and intrigue, adventure and color galore. Yet it did not succeed in persuading me to suspend my disbelief. One problem is the silliness of magic spells and demons. Another is the lack of logic

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in the story itself.

The first problem is insoluble, for it is inherent in the nature of fantasy. The second could have been avoided by developing the background more carefully and thoroughly, which would surely have made the tale less thin in two senses. On the other hand, neither problem ever seems to bother fantasy fans. If you count yourself among that number, focus on Gentle's strengths, and enjoy.

If at Faust You Don't Succeed is the sequel to Roger Zelazny's and Robert Sheckley's *Bring Me the Head of Prince Charming,* which I thought fairly feeble in its humor and barely sturdy enough in its satire to stand up. Indeed, when this one came my way I almost didn't read it, and that would have been a shame, for it is rather better than its predecessor.

The central idea is still that every thousand years, the forces of Good and Evil must contest to decide which will dominate the fate of humanity for the next millennium. This time, the demon Mephistopheles and the Archangel Michael decide to take a different tack: They will offer Johann Faust, philosopher, magician, alchemist, and egotist, his heart's desire if he will let them set him down in five different moments of history. There he will make a choice, and the choice he makes will determine whether Good or Evil will rule the affairs of humanity for the coming millennium. The judge will be Ananke, the goddess of Necessity.

Unfortunately, when Mephistopheles poofs into existence in Faust's chambers, the only human present is Mack the Club, a lowlife burglar just bright enough to keep his mouth shut until it becomes clear that it could be very profitable to pretend to be Faust. And then he is off to play the game the gods and devils have devised. Neither good nor wholly evil, really pretty representative, a common man on the threshold of the age of the common man, wooed by both Good and Evil, pursued by the intellectual Faust who wants his place at the high table of Destiny, and this time Zelazny and Sheckley have a sharper point to their humor. I thus found it much more satisfying. It didn't hurt that though demon Azzie and witch Ylith (and others) appear again, they no longer seem present merely to stir the froth.

The froth is there, of course, but now it really does make you smile.

I enjoyed the first one or two of Piers Anthony's Xanth novels, but then they began to strike me as increasingly silly. It has therefore been a long time since I last picked up another. Meanwhile, the series became quite astonishingly popular.

Should we be surprised? Surely not, for bestsellers are not noted for their depth. Yet, well, mmmm. One wonders, doesn't one? And here's the latest, the sixteenth, in the mail, so let us not dismiss it quite out of hand. That is, let's have a look at **Demons Don't Dream.**

It begins with a pair of teen-aged boys, Dug and Ed. Dug is impatient with brainless computer games. When Ed assures Dug that he will just

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love "Companions of Xanth," Dug bets his girlfriend against Ed's motorcycle that he won't. Dug plays fair, too: When the game arrives, he sits down to play it. Very quickly, he is utterly absorbed. In fact, he seems to be in Xanth, a player in a game arranged by demons to decide the fate of Xanth. All he has to do is keep his mind off Nada Naga's panties, defeat the game's various challenges, and win through to the end, wherever that may be.

Now meet Kim, a second human player of the game. She and Dug like each other and are more interested in experiencing the wonders of Xanth—mermen and pieplants, bubble dogs and censor-ships, eye scream and Ice Queen Crones, dragons and centaurs, loan sharks and diggles—than in winning. Yet win someone must, and with the aid of Xanth's exceedingly pun-drenched brand of magic and a few lessons in responsibility, generosity of spirit, and loyalty, one of them does.

Puns? Well, yes. That is a very large part of what Xanth is all about (consider three of Anthony's titles: *Heaven Cent, Isle of View, Phaze Doubt*), and they're not even all his. As he notes at the end, many have been contributed by his fans.

Are the puns any good? Do they serve any function other than to increase the silliness level to the verge of intolerability? Here's what Anthony says:

" '. . . You know, this place—what do you call it, Zanth—might be okay if it wasn't for all the stupid puns.'

" 'They are there for the critics,' Nada explained. 'Because the critics can't handle the intelligent puns, and they hate to think they're missing anything.' "

Harrumph. If the critics choose to ignore the series, they aren't missing much. On the other hand, the series' success testifies that its silliness strikes an undeniable chord with readers of the right age (younger, I suspect) or of any age but the right mood.

Omni Best Science Fiction Two, edited by Ellen Datlow, is much like the first in the series: an interesting mix of four stories reprinted from the magazine and six brand new. For the oldies: Tom Maddox's "The Robot and the One You Love" is a tale of love and betrayal by a robot that is developing a sense of responsibility for its actions; sadly, the parts don't mesh well enough to satisfy. Gregg Keizer's "Chimera Dreams" gives us a future when people wear "chimera cloaks" and take drugs to don the personas of animals; now ancient nemeses find they can doff *their* disguises. George R. R. Martin's "The Pear-Shaped Man" is a horrific mood piece with no logic to it whatsoever. Bruce McAllister's "Kingdom Come" sets in New York an other-worldly window through which fly things best described as angels and devils; humans struggle to comprehend and survive, and when one opens the door of his apartment (for which, read heart), he beholds . . . The result is quite effective.

The tale I liked best was among the new ones: Pat Cadigan's "Mother's Milt," which offers a clever and biting

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take on the problem of how to cope with criminals. Garry Kilworth's "The Cave Painting" is also memorable, with its portrayal of the Australian Dreamtime as a vision of creation complete with retakes.

And here are the rest: Lucius Shepard's "All the Perfumes of Araby" offers a ne'er-do-well wheeler-dealer, a lady seeking a whiff of danger, and an unwelcome drug deal gone bad with strange results. Maggie Flinn's "Black Velvet" tells us that the concealment of a talent can be a weapon of vengeance. Dan Simmons' "One Small Step for Max" is a fairly routine tale of a small-time crook's final pratfall. Elizabeth Hand's "In the Month of Athyr" gives us a glimpse of the world of *Winterlong* and *Aestival Tide*, but elsewhere, in the orbiting HORUS (Human Orbital Research Units in Space) stations, where women are being converted into males in the name of purity but men have constructed gene-slave sex-toys to meet their needs. She asks: What might those sex-slaves think of it all?

Robert McCall has for many years struggled to capture the space age in paint, to convey the exultant spirit of exploration that so captivates many SF readers, to present images of potential futures. Much of his work has been done for NASA. Some is on display at Disney World's Epcot Center. A gigantic mural graces the Smithsonian's Air and Space Museum, and when Ray Bradbury first saw it through locked glass doors, illuminated by flashes of lightning, it filled him with awe and tears and glory. Now you can share that glimpse and more in a coffee-table presentation, **The Art of Robert McCall: A Celebration of Our Future in Space.**

Bradbury's moment of glory leads into his introduction here. He says, in brief, that mainstream, modern art, at least as represented by Warhol, Pollock, and the "gallery owners who smell of calliope steam," is so dead-end moribund that it is already stinking. The modern heirs of Michelangelo, Rembrandt, and Van Gogh are those who, like Robert McCall, sing of the human spirit and its most glorious aspirations, of space and technology and the future.

The book demonstrates that at his best McCall deserves every word of Bradbury's fulsome praise. It is easy to imagine him doing some futuristic Sistine ceiling—in fact, he shows us here that he has done church work on commission, and the Air and Space Museum is for many cathedral enough for our age. But one can also sniff a kinship to "Socialist Realism"—the worker-praising poster art of the old USSR. There is a mawky excess of sentimentality. There is a tendency for the artist to turn choice bits of gadget or image into his own personal clichés. By the time we are done perusing the book, we feel that Bradbury is a bit too much the hired gun of an introducer, fulsome indeed.

On the other hand, ancients such as Michelangelo also served their patrons, exploited sentiment, and invented their own clichés. They live for their excellence. And perhaps McCall will too. For all my carping, it's a lovely book. ■

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BRASS TACKS

Dear Stan:

I read G. Harry Stine's "Alternate View" in the December '92 issue.

I am an engineering technologist, and proud of it. While I have never bent tin, I solder with its alloys well enough to meet spaceflight standards. I *do* frequently bend steel and aluminum, as well as drill, turn, mill, weld, etc. I design, build, and repair electronics; program and troubleshoot computers; and use and maintain a servohydraulic fatigue machine as well as a building full of other physical testing equipment. I've worked with exotic alloys, composites, honeycomb, elastomers, and dozens of other materials. One day I might be doing carpentry or plumbing, the next, writing a proposal for a NASA project. Today, I was looking for a nice little inertial platform in Thomas' Register. I scrounge parts from old projects stored in The Loft (some of them dating back to the NACA days). I have hair in my ears, but my britches are polyester because they're cheap and I ruin a lot of them. I've even ruined some equipment, but don't tell my boss.

Like Mr. Stine, I've been working with a local company developing a launch system. The young rocket scientists are receiving an old-fashioned practical education in "real" engineering. They've gotten their birds into orbit, too. I suspect these kids will do fine, and just might be the ones to build the DC-3 of space, in spite of the education they received.

The electrical engineering technology curriculum at my *alma mater* included about the same courses as the engineers took, but with a bit less emphasis on math. We could *do* Laplace and Fourier Transforms, but *they* could do them in their *sleep*. However, *every* course we took included lab work. We flashed generators, built transmitters, breadboarded computers . . . in other words, we bent tin. The electrical engineers, on the other hand, got through their junior year without setting foot in a lab, and rarely had more than one lab a quarter. When we graduated, industry had great things to say about the engineering technologists, but complained that the engineers needed a few years of OJT to be useful. The engineering curriculum was designed as graduate school preparation, which wasn't suitable for the 80% of graduates who struck out for the real world with only a BS.

And yet, after only a couple of years, the College of Engineering declared the ET program a failure to be

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canceled! We were shocked. We asked what had gone wrong. We were told, privately, that the program was unsatisfactory because we were being hired for *engineering* positions, and being given the title of engineers! This hurt the prestige of the university. Particularly, it ticked off certain members of the faculty.

After giving this some thought, I discussed it with the dean. I pointed out (and he agreed) that the engineers had too little lab experience, and that they would never be able to get it in a four-year program while still keeping the required classroom work load. This *had* to hurt the university's prestige. I suggested that they keep the Bachelor of Science Engineering Technology program (considered one of the best in the country), but change the engineering program to a Bachelor of Engineering degree of five or six years, as the *really* top schools do. Thus preserving one outstanding program, while upgrading the other from a mediocrity, to one with some real guts.

Alas, it was gently explained to me that most kids entering college wouldn't want to commit to the time and expense of so long a program.

Where are the real engineers? Oh, I suppose a few eventually discover themselves, after a few years of life in the real world. One thing is for sure, there are certain minions of academia, themselves supposedly old-fashioned "real" engineers, who are dead set against anyone receiving the same kind of education they did. These characters have placed themselves in key positions at the spigot from which the new talent flows, and, for reasons I cannot guess, are deliberately changing the nature of newly hatched engineers. I hope Harry and I aren't the only ones bemoaning this trend. A big enough stink raised by American industry might change it.

TOM LIGON

Dear Mr. Schmidt:

Paul Birch's "A Visit to Suprajupiter," Dec. '92, was as refreshing and exhilarating an excursion into SF speculation as anyone could ever hope for; a real fountain of ideas and a tribute to what *Analog* does so well.

However, the inclusion of Mr. Birch's essay as "science fact" makes me nervous. Please tell me it's all in good fun. Serious or not, I would like to raise a few cautionary points.

I hope Mr. Birch presumes his "G" to the nth grandchildren will know all the relevant risks and consequences of all this supraplanet building. The effect of depriving gas giants of sunlight, or the shutting off of sunlight and the solar wind, while not even hinted at in the essay, hardly seem like inconsequential tampering. While it may be eons before we wean ourselves from sunlight in its crude, raw form, is it reasonable to suppose that the rest of the Solar System will then be so forward looking as well?

Also, and perhaps more importantly, I hope Mr. Birch can propose a realistic motivation for the human race tackling such titanic projects. As a way to accommodate an out of control human population explosion, it seems a most dangerous suggestion.

If Mr. Birch truly believes he has

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found a loophole in the Malthusian principle, he should reconsider carefully. What could be gained by giving false hope to an Earth-bound humanity reduced to burning furniture to stay alive? If we do survive that, is it realistic to think we could create billions of times what we almost destroyed here? And even if we could, wouldn't such mighty efforts merit higher purpose than mere real estate development? Let's hope that if we have supraplanets, they will be above the mundane uses ascribed to them.

I get skeptical of the heady predictions and extrapolations of the highly educated in the sciences and technology, especially when their predictions are couched in such glowing, far future terms. These thinkers seem to know only that their futures are possible, and seem to assume that therefore these futures are desirable. But remember that nuclear energy was going to give us electricity so cheaply it wouldn't be worth metering.

Against such nay-saying the priests of the temple of science bemoan the shortsightedness, lack of vision and scope of the less educated. But scientists have no monopoly on wisdom, or foresight. Man rushed headlong into the industrial revolution without regard to the social or environmental costs. Should we think no more deeply before we rearrange the Solar System?

Lacking a more sensitive appraisal of the reasons for supraplanet building, I can only conclude that Mr. Birch has been seduced by the myopic marriage of science and technology that pushes us pell mell into more crises than out. To do something only because "Yankee ingenuity" makes it possible is childish.

Hopefully fiction writers will soon take up Mr. Birch's ideas and point out their pitfalls and possibilities. Scientists often seem unable or unwilling to examine their own ideas beyond the facts and figures. But fiction is uniquely able to examine the human truth behind those cold facts and figures. That is why I read *Analog* and why, I assume, *Analog* keeps bringing us such wonderfully exotic notions.

JOHN VESTER

Rancho Cordova, CA

The author replies....

I quite agree with you about the advantages of fiction: that's why I wrote the article the way I did. I'm glad you found it exhilarating.

Motives for the construction of supramundane planets are many and various. Some may be ideological (to promulgate a religious or political creed, to spread mankind), scientific (to learn about extensive ecosystems), aesthetic (to create beautiful landscapes), economic (to further industrial growth, to make money), or pragmatic (to diversify human habitats, to ensure survival). One might build them for military advantage, or simply for entertainment. Almost any reason for winning land or erecting buildings on Earth will also apply in space. Take your pick.

As for me, I believe we must fill the Universe and subdue it, because God made it for us and commands us to—the same belief that motivated the builders of the great cathedrals.

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My designs, with their facts and figures, spring from that conviction.

If Jupiter and the gas-giants are uninhabited (as I assume), depriving them of sunlight hurts nobody.

As for finding a way out of the Malthusian trap, we were never in it; we only thought we were. Even on Earth, current technology would allow population to grow by *at least* a further factor of 40,000 (though in space we can also provide an ever-increasing area of land per person). The terrestrial environment is nowhere near destruction; we've *not* spoilt it, we've improved it. The so-called limits to growth are nonexistent.

Don't be so ungrateful; electricity is *far* cheaper now (relative to wages) than before the advent of nuclear power (by about a factor of five).

Have I considered the problems that might arise on Suprajupiter? Of course I have. They're the problems common to people everywhere; people will still get divorced, vote for venal politicians, complain about the very technologies that keep them alive—because I *designed* the planet to be Earth-like. So there'll still be crime out there, and there'll still be wars—for as long as people are people. And a jolly good thing too!

PAUL BIRCH

Dear Mr. Schmidt:

"A Visit to Suprajupiter," was certainly interesting, but I can foresee certain disaster if it is ever attempted. For example, what if a crack developed in Suprajupiter? The drawing shows a vacuum between Jupiter and Suprajupiter, so all the atmosphere would rush through the crack and be lost, people would suffocate.

If I read it right, Suprajupiter would have a crust only five meters thick. Even a small meteorite would breach it, letting the air escape. The drawing shows huge hydrogen gas-bags to hold in the atmosphere. What if a small meteorite punctured some of them? The hydrogen mixing with air would form a flammable or explosive mixture, igniting the rest of the gasbags.

Also, I don't see any way to keep Suprajupiter accurately centered around Jupiter. If it got slightly off-center, gravity would pull that side down, and the whole Suprajupiter would come crashing down. It wouldn't be possible to anchor it to Jupiter for two reasons: the difference in rotational period between Jupiter and Suprajupiter, and because there isn't any solid surface on Jupiter to brace anything against.

The first people who went to Jupiter to start constructing Suprajupiter would be subjected to a lethal dose of X-rays from Jupiter. So, altogether I'd say it's a wonderful dream, but that it will remain just that, a dream.

ROBERT D. SMITH

P.O. Box 92
Olds, IA, 52647

The author replies . . .

Only a very large meteorite, such as strikes Earth every million years or so, could plough right through the atmosphere and the kilometers-thick geosphere base. It may happen, mind. But since it would take some 20 million years for the air to leak through a hundred-meter diameter hole there'll

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be plenty of time to bung it up.

The self-sealing gasbags are only temporary, and the amount of hydrogen we can expect to lose through punctures isn't enough to worry about. In the upper atmosphere it won't even burn, let alone explode.

Actually, the dynamics of a supramundane planet are more like those of an orbiting constellation than of a solid body, so the instability you cite doesn't exist; gravity itself is the anchor. However, subtler stability problems do arise, and overcoming them presents the greatest difficulty in the design of supramundane habitats.

The radiation environment of Jupiter, although severe, should not interfere with the construction of Suprajupiter: modest amounts of mass in suitable orbits can mop up the radiation belts very rapidly.

Thanks for your interest; you'll find these points discussed in more detail in my paper "Supramundane Planets," *J. Brit. Interplan. Soc.*, **44**, 169-182 (1991).

PAUL BIRCH

Dear Editor:

I subscribe to *Analog* to read science fiction. If I'd wanted to read anti-liberal political polemics, I'd have subscribed to *National Review*. In David J. Strumfels's "Road To Hell" (Dec. '92), I resent being portrayed as a member of the leftist reactionary camp because I oppose animal testing. I am an environmental scientist, and I oppose most animal testing that is being done because it is bad science, science that does nothing to further the well-being of the human race.

Animal testing is used to determine the various degrees and characteristics of the toxicity of a particular chemical. For instance, the 'LD-50' test determines the point at which 50% of a group of test animals (generally rabbits) die from exposure to a certain amount of some chemical—say, a 70% solution of sulfuric acid being poured onto the subjects (dermal exposure) or down their throats (ingestion hazard). Or, the acid could be introduced as vapor into a closed room holding them—well, use your imagination. As if these poor creatures had to be subjected to such horribly torturous deaths (and they were the lucky ones; remember, half the rabbits *survived*) so we could know for sure that drinking acid is bad for us.

Here's what I mean about such testing being bad science (as opposed to simply being incredibly cruel): such measurements of "acute toxicity" (what can hurt or kill at once, or soon thereafter) are extrapolated and applied to risk assessments of "chronic toxicity" (what can hurt or kill if you ingest/absorb/inhale it in small amounts for many years). Such extrapolations are bullshit. Scientists who perform the testing will tell you they are the best they can do, but that doesn't change the fact that the results are meaningless and are doing nothing to protect public health. People found out about the chronic toxicity of substances like benzene, asbestos, and carbon tetrachloride by observing that people who worked with them for long periods tended to

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sicken and die. In other words, many substances which are commonly used and ingested by the general population and which we are assured are safe to use (based on extrapolated acute toxicity test results) could be, in fact, slow poisons. A few years back, I read that *four hundred thousand* people in the US get cancer every *year*. Why so many?

My point is most animal testing being done in my field is a pointless exercise in sadism done to satisfy mindless bureaucratic requirements. I have watched two people die of AIDS. I have watched twice that number of friends and relatives die of cancer. They are both slow, painful, bankrupting deaths, but cancer kills a lot more people; and I am convinced that an enormous number of these cancers are environmentally triggered and therefore preventable. However, we have a health care establishment that, when faced with a group of people insisting something is making them sick and a group of rats doesn't get sick when exposed to that something, believe the rats.

The medical establishment needs to stop protecting the industry status quo and protect *us*. Don't wait until your cancer diagnosis for this issue to become important to you! Remember, the odds are excellent that one day you *will* get that diagnosis.

RACHEL LERNER

Clivington, NJ

It's fascinating that readers with strong anti-animal research views tend to see that story as "an anti-liberal political polemic" and completely miss everything else that was in it! You say that your objections to animal research are based on its being "bad science," but the valid criticisms you make concern the way data is interpreted and have nothing to do with whether or not it was obtained from animal experiments. The distinction is important!

Dear Dr. Schmidt:

The Mid-December issue was pretty good, as usual, but one letter upset me so much it ruined all the enjoyment I might have otherwise gotten from it.

It just so happens, Mr. Frank B. Harris Jr., that I thought "Green Fuse" was one of the best stories ever printed, in *Analog* or elsewhere, and I hope it wins a few dozen awards. I've been reading *Analog* twenty years less than you have, but that also means I have a pretty good chance of being a source of income for them for about twenty years longer than you do.

If you think that showing the folly of raping living ecologies for short-term private profit is "grinding an outrageously left-wing axe," then you are more ignorant and selfish than I had believed possible even among the few remaining Reagan-era worshipers. If there was any justice in this world, then only us "left-wingers" would have clean air to breathe and clean water to drink.

And since you mention it, *I* thought "On the High Frontier" was one of the more clever and entertaining stories published in years. Given your greedy and arrogant disposition, I'm glad it annoyed you.

DIAN HARDISON

Cocoa, FL ■

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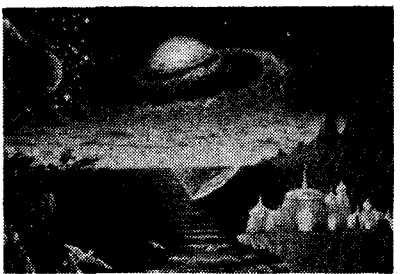

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UPCOMING EVENTS Anthony Lewis

30 July-2 August
MYTHCON XXIV (serious mythopoeic conference) at University of Minnesota/Twin Cities, Minneapolis, Minn. Guest of Honor—Jane Yolen. Info: attn: Joan Verba, Mythcon XXIV, Box 1363, Minnetonka MN 55345. (612) 292-8887. GEnie D.LEANDER

6-8 August
RIVERCON XVIII (Louisville area SF conference) at Hurstbourne Hotel & Conference Center, Louisville, Ky. Guest of Honor—Joe Haldeman; Fan Guests of Honor—Jane & Scott Dennis; Artist Guest of Honor—Vincent DiFate; TM—Bob Tucker. Registration: $20 until 20 July, $30 thereafter. Info: RiverCon, Box 58009, Louisville KY 40268-0009.

7-11 August
The Asimov Seminar at The Rensselaerville Institute. This year's topic is "First Contact: The Human Impact"—seminars will consider the reaction of human beings to alien contact. Seminar advisors will be headed by Ben Bova. Info: The Asimov Seminar, The Rensselaerville Institute, Rensselaerville NY 12147. (609) 629-3732 [Don McGrain].

19-22 August
24th Annual San Diego Comic-Con at San Diego Convention Center, Calif. Guests: Roger Zelazny, Michael Whelan, Robert Williams, Murphy Anderson, Jerry Scott & Rick Kirkman, Charles Vess. Registration: $40 until 10 July ($20 for 7-16 and 60+), $50 ($25) at the door. Info: Comic-Con, Box 128458, San Diego CA 92112. (619) 685-8118.

2-6 September
CONFRANCISCO (51st World Science Fiction Convention) at Parc 55, ANA Hotels, Moskone Centre, San Francisco, Calif. Guest of Honor —Larry Niven; Artist Guest of Honor —Alicia Austin; Fan Guests of Honor —Tom Digby and jan howard finder; MC—Guy Gavriel Kay. Registration at the door—Attending $145; (children 7-12 $30; kids-in-tow 0-8 fee). Supporting—$25. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition —the works. Info: 712 Bancroft Rd, #1993, Walnut Creek CA 94598. (510) 945-1993. CompuServe 72377,3623.

You can send me e-mail about your convention—A.LEWIS20 on the GEnie™ network. When calling conventions for information—do not call collect. ■

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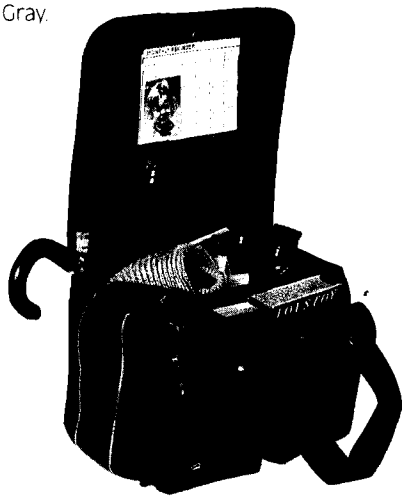

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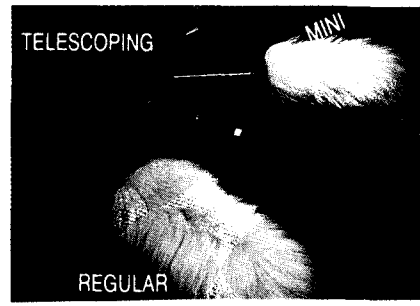

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